ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. 57. No. 26. 220 Broadway, New York, June 27, 1907.

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THE WATER AND ELECTRIC POWER SYSTEMS OF THE PORTLAND RAILWAY LIGHT AND POWER COMPANY, PORTLAND, OREGON.

By W. P. HARDESTY,* C. E.

The works described in the following article have a history of growth which, if given in detail, would well serve to illustrate the progress made in the science and art of electric light and power production during the past score of years. However, space allows but a brief description of the older portions of the existing system, a detailed explanation being given of only the latest addition to it.

The Portland Railway Light & Power Co., of Portland, Ore., is a consolidation of three other companies, the principal one being, as regards light and power, the Portland General Electric Co. In the merger the capitalization was fixed at $30,000,000, there being $15,000,000 each of common and of preferred stock. The consolidation was completed about July 1, 1906. The Portland General Electric Co. has furnished practically all the lighting and power current used in Portland and the adjacent small cities during the past fifteen years. The only source of water power has until the present year been the Willamette Falls at Oregon City, thirteen miles up the Willamette River (southward) from Portland. This has been supplemented by steam plants located in Portland. In February, 1907, a new hydraulic generating station, on the Clackamas River, near Cazadero, Ore., has been put into service on the system.

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Hydro-Electric Plants at Oregon City.

Oregon City is just above the head of deep water navigation on the Willamette River. During low water there is but 7 to 8 ft. normal fall in the river from the foot of the Falls to Portland, and thence to the Pacific Ocean (by way of the Columbia River) the fall is less than 6 ft. additional. The Willamette Falls, well shown by the view on this page, are formed by nearly precipitous breaks in the basaltic rock bed of the river, somewhat in the form of an elongated horseshoe with the toe upstream. The total natural fall in the river during low water is about 40 ft. The water pours over all sides of the horseshoe into a narrow gorge, which contains the river.

The river widens out somewhat just below the Falls, but continues comparatively narrow (only 400 to 600 ft. wide) to a distance of nearly a mile below, when it again expands to its normal width of one-fourth to one-half mile. This contracted portion is insufficient in carrying capacity to pass the water during high stages without it piling up to a great depth. This very much reduces the surface drop at the Falls, so that it sometimes becomes only about 20 ft., although the level of the upper river is not much raised. Another cause of reduction of head operates usually during May and June. This is flood season for the Columbia River, whose high water causes backing up of the Willamette from its junction to the Falls, a distance of about 25 miles, resulting in much higher water at the foot of the Falls.

The drainage area of the Willamette at the Falls is about 10,000 sq. mi. During August and September, and part of July and October, the low stage of the Willamette occurs, and the discharge then sometimes reduces to 6,000 to 7,000 sec.-ft. The average flow is probably 50,000 to 60,000 and the maximum about 350,000 sec-ft.

WILLAMETTE FALLS, OREGON CITY, ORE.; LOOKING UPSTREAM FROM WEST BANK.

The first development of water power at the Falls was made in 1854, when an agent of the Hudson Bay Co. built a grist mill on Abernathy's Island, on the east side of the river. Some years after this a transportation company built a basin on the east side just above the Falls to make an easy and safe place for the landing of steamboats at Oregon City. The "Basin" was also used as a canal and forebay for other mills that were established at the edge of the Falls. The Oregon City Woolen Mills (still in operation) were built in 1865.

In the early seventies the Peoples Transportation Co. built the Willamette locks, used for navigation between the upper and lower rivers, and they were completed on Jan. 1, 1875. They

are on the west side of the river. After changing ownership several times the locks in 1892 passed into the possession of the Portland General Electric Co., the latter consisting of the consolidation of two other companies. At the same time the consolidated company became owner of the entire water rights at the Falls. The

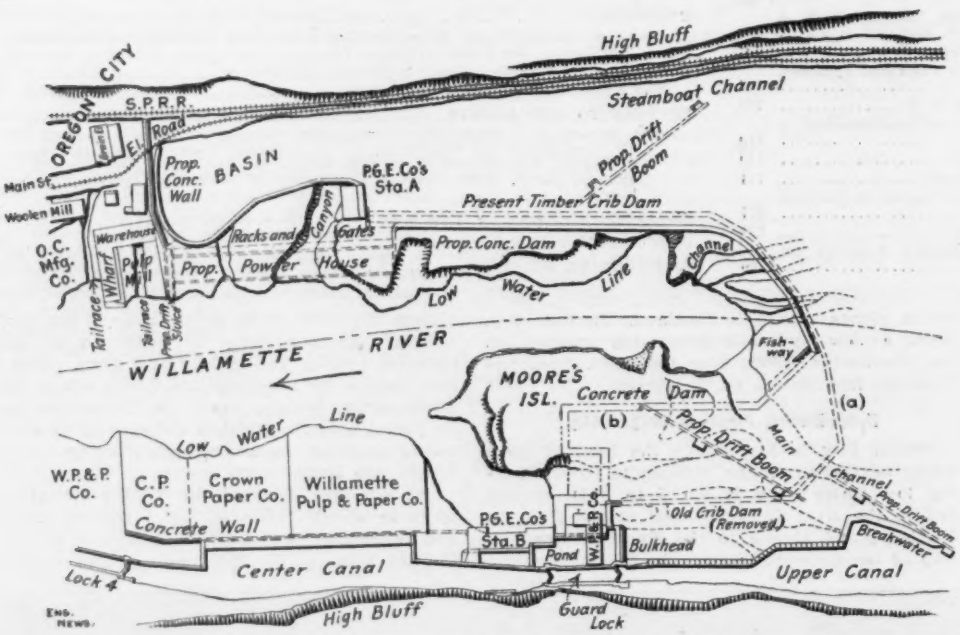


FIG. 1. MAP OF WILLAMETTE FALLS AND ADJACENT INDUSTRIAL AND POWER DEVELOPMENT.

locks fill the double purpose of serving the river navigation and of supplying, through their canal, part of the power plants. There are four locks, each 40 × 210 ft., designed for a 10-ft. lift, above which is a center canal 1,200 ft. long separated from the upper canal of 1,500 ft. by a guard lock. The map of the Falls, Fig. 1 herewith, shows the location of the canal with respect to the Falls and the west bank.

STATION A.—In 1889 the Willamette Falls Electric Co. completed the first hydro-electric plant at the Falls, probably the first in Oregon. This was a wooden station on the east side, in which were installed six Westinghouse 80-KW., 125-cycle, 4,000-volt generators, which were all run by Victor turbines, and also two Thomson-Houston 2,000-volt generators. The voltage of the Thomson-Houston generators was stepped up from 2,000 to 4,000 volts by means of transformers and transmitted down the east side of the river to Portland, while the current from the Westinghouse machines was transmitted at its initial voltage of 4,000 down the west side to Portland. The operation of generators at this potential was at this time unprecedented, and great difficulty was experienced in inducing the Westinghouse people to undertake their building. Nothing over 2,000 volts had been attempted before. The line to Portland, 15 mi., was the first long-distance transmission line in this country. In the transmission were eight single-phase circuits, one for each generator. This plant, known as Station A, has since been entirely abandoned.

In 1892 the Willamette Falls Electric Co. and the Willamette Transportation & Locks Co. were consolidated into the Portland General Electric Co., which latter has since supplied practically all the lighting and power current used in Portland.

STATION B.—In 1894 was completed and put into operation the first portion of the present modern plant at Oregon City. This is known as Station B, and it is located on the west side of the Falls, adjoining the locks canal, which the company also owns and operates.

The diversion of the river flow from its course over the west part of the Falls to the forebay was first accomplished by a timber dam, (a) in Fig. 1. This was built far back from the edge of the Falls, curving around to near the upper end of the Falls. It was a timber crib rock-filled dam, well fitted and secured to bedrock with iron anchor bolts, with planked deck. The upstream slope was 2:1 and the downstream slope 1:1. The apex or crest was of heavy timber, rounded off. The height varied from 3 to 10 ft. This timber dam, built in 1894, was still in good condition in 1904, when it was replaced by a concrete dam, (b) in Fig. 1, made necessary by reason of the increased diversion called for by new works at the Falls. The new dam was built much farther out towards the edge of the Falls and it has a total length of 2,460 ft. It renders possible a full utilization of the flow of the western part of the river during low water.

The power-house, a view of which is given in Fig. 2, is of concrete with timber truss roof. It consists of a series of pier walls with arch openings, connected and reinforced by iron rods imbedded in the concrete. On the west side of the building, between it and the locks canal, is its immediate forebay or pond. Water is admitted to the penstocks through gates in the west wall of the building, the gates being slide gates operated by hand power through gearing. The penstocks are steel plate pipes. The tailrace is a natural recess or arm of the river, into the edge of which the station was built.

The power-house basement is divided into sections, one section for each set or pair of turbines. The first sections were built in 1893-94, seven more were added in 1896-97; the two final sections were added in 1903. The building is 246 × 30 ft., but 40 ft. of one end has a width of 64 ft.

The site of the power-house is such that the building of foundations was extremely difficult. Over one-half of its area consisted of pot-holes with loose rock and these had to be cleaned out. It was necessary to go 36 ft. below low water for bedrock. Over 20,000 bbls. of Portland cement were used in constructing the station.

Hydraulic Equipment.—The physical conditions here are quite exacting, as the hydraulic installation has to be capable of working under a maximum head of 40 to 42 ft. and a minimum head of only 20 ft.

There are ten 42-in. Victor vertical-shaft turbines, each direct-connected to a generator on the wheel-shaft in the room above, and ten 60-in. vertical-shaft turbines. One of each of these sizes of turbine is placed in the same section or compartment. The smaller wheel is so placed as to utilize the higher head during the low-water stage. The larger wheel is placed back of the other one, it being designed for use during high-water (low head). Its power is transmitted to the shaft of the smaller one by belting, there being a 46-in. double leather belt whose tension is regulated by a belt-tightener. Both turbines have draft tubes, and it is customary to run both at ordinary stages. During times of high-water in the lower river, when the head obtainable does not exceed about 30 ft., only the 60-in. wheel is operated. During the lowest stages, when the supply is insufficient, only the 42-in. wheel is used, as it is more efficient.

The wheels have a vertical height of 21 ft. above surface of the tailrace during low-water. Both the wheels are arranged so as to drive the generator at the fixed speed of 200 r. p. m. at all heads from 20 to 40 ft.

There are also two separate 48-in. Victor turbines, each carrying a direct-current generator.

FIG. 2. GENERATING STATION B, AT OREGON CITY, ORE; VIEW OF RIVER FRONT.

There are, further, two pairs of 51-in. McCormick horizontal-shaft turbines, each driving a three-phase generator at a speed of 143 r. p. m. All the turbines have cylinder gates.

All of the vertical wheels except the 60-in. turbines are provided with ring and oil-pressure-piston thrust bearings. The 60-in. wheels have

only ring thrust bearings. The piston bearings are placed in cases, supported on cast-iron columns, and they are arranged to carry the weight of the revolving part of the generator, and of the pulleys and shafts. No part of these weights comes upon the water-wheel steps, as each shaft is in two parts, connected just above the wheel by a pin drive or jaw coupling.

Electrical Equipment.—The generator room, Fig. 3, is 246 ft. long by 38 ft. wide. The concrete walls are 17 ins. thick and 20 ft. high, and the room is well ventilated by twenty-six windows. It is equipped with a 12-ton electric traveling crane.

The generators extend in a row down the room. They are as follows:

Seven 450-KW., three-phase, 10,000-volt, revolving armature, 33-cycle machines.

Three 500-KW., three-phase, 10,000-volt, revolving field, 33-cycle generators.

Two 540-KW., three-phase, 10,000-volt revolving field, 33-cycle machines.

Two 200-KW., 500-volt, D.C. street railway generators.

All of the generators are of General Electric make. The two 540-KW. generators are horizontal and the others vertical. There is also a 500-KW. motor-generator set for serving as frequency converter, to change current from 33-cycles, 10,000 volts, to 60-cycles, 2,300 volts, for power and light use in Oregon City.

The switchboards are of standard General Electric types, with hand-operated, 10-000-volt single-pole oil switches, mounted in concrete compartments. The feeder circuits after leaving the switchboard pass out over the locks canal to the pole line leading to Portland.

PROPOSED NEW PLANT AT WILLAMETTE FALLS.—The Portland Railway Light & Power Co. will, during the summer of 1907, begin work on an entirely new and much larger plant. This is to be located on the east side of the Falls, near the original plants. It will, however, be placed directly on the edge of the line of Falls on this side, while the older ones were farther back towards the shore. The power-house will be about 700 ft. long by 80 ft. wide, and it will be equipped with fourteen 3,000-HP. units. For the diversion of the water there will be built a concrete dam. This will be inside of the present timber crib dam, close to the crest of the Falls, and will extend upstream from the power-house, curving around to the upstream center of the Falls, where it will join with the dam built for the west side plants. When this is completed, and some additional work done on the walls of the locks canal, the entire flow of the river at ordinary low stages can be used for power, except the small amount used in operating the locks. It is not expected, however, that the new plant can be run to anything like its full capacity during the three months of the low-water season. The intention is to build it in sections, as the installation of two to four units each year will keep up with the increased demand for power.

FIG. 3. GENERATOR ROOM OF STATION B, OREGON CITY, ORE.

OTHER WATER POWER DEVELOPMENTS AT THE FALLS.—As already mentioned, the first utilization of the Falls was for ordinary industrial purposes. This use has gradually increased until there are at the present time the following concerns using water power direct in their work:

FIG. 4. THE DAM ON THE CLACKAMAS RIVER, NEAR CAZADERO, ORE.

The Willamette Pulp & Paper Co., having (it is claimed) the largest and most complete mills west of New York State, can develop 15,000 to 17,000 HP. when water is plentiful. As the grinding of pulp requires much the greatest use of power, this is done during the season of plentiful water, about nine months, and a sufficient supply accumulated for the mills to continue work on during the low-water season. The mills also have an agreement by which they can develop 2,400 HP. at all seasons. The works of this company are located on the west side, both above and below Station B. Water is taken from the main forebay and from the locks canal. For one of its buildings, located some distance below the forebay, use is made of electric power generated at one of the older buildings adjoining the forebay.

The Crown Paper Co. uses between 2,000 and 3,000 HP. when water is plentiful. It has a pulp mill on the east side, which is shut down during low water, but the main works are on the west side.

The location of the mills of both companies directly on the locks canal gives them excellent boat facilities. These mills have been in operation since 1889. The Willamette Mills have steam boilers to the extent of about 4,000 HP., about 2,500 HP. of which is used in cooking sulphite pulp, the balance being used in steam engines for operating paper machines. In the Crown Mills about 900 HP. in steam is used on the sulphite pulp and in drying paper.

Besides the paper mills there are the large woolen mills of the Oregon City Mfg. Co. and the Imperial Flouring Mills, both at the north end of the east side.

All of the foregoing occupy their premises and use water only as lessees of the Portland General Electric Co. Water is diverted from the large forebay on either side of the river, or from the locks canal, which have been described before.

TRANSMISSION TO PORTLAND.

The present transmission lines from Willamette Falls to Portland are reconstructions of the older lines. There were two of these, one on each side of the river.

West Side Line.—This runs from the power-house (Station B) to Substation A in Portland, a distance of 15 miles. It is a single pole line, with 50-ft. poles used outside of the city and 60-ft. poles in the city. The pole line once bore ten single three-phase circuits, there being seven or eight cross-arms required to carry the thirty

wires. Of these, 24 were No. 4 and 6 No. 1 wire. The reconstruction (done in 1904-05) changed the line to a double circuit operating at 10,000 volts, three-phase. The old wires were combined, six of the No. 4 being twisted to form each of two legs of the circuit and three of the No. 1 for the remaining leg, thus using 15 wires in each of the two circuits. There are two double cross-arms, each made of two pieces of 4 × 6 × 9 ft. fir. Each side of the pole is given to a circuit. The three wires are spaced equilaterally, 24 ins. on a side, two wires being on the upper cross-arm and one on the lower one. The inner legs of the two circuits are spaced 48 ins. apart. A double-petticoat glass insulator designed for 25,000 volts is used.

East Side Line.—This line crosses over to the east side of the river at Oregon City and follows down the east side to Substation D in East Portland. There were formerly three three-phase circuits, No. 4 wires being used. The present line is a single three-phase circuit, each leg being made of three of the old wires twisted together, and they are placed on the same cross-arm in horizontal row.

The East Side Line passes through Sellwood, a junction station on the Oregon Water Power & Railway Co.'s Cazadero line, where connection is made with a substation for supply of power current to the railway.

The Cazadero Plant.

The Cazadero hydro-electric plant is the latest addition made to the system of generating plants operated by the Portland Railway Light & Power Co. It was put in service on February 26, 1907. This development was made on the Clackamas River, in Clackamas County, Ore. The power-house is 25 mi. in an air line southeast of Portland. The locality is reached by the electric suburban railway of the Oregon Water Power & Railway Co. The terminus, Cazadero, is 38 mi. by the railway from Portland, and about one-half mile beyond the power station.

The power development here was planned by the Oregon Water Power & Railway Co., and work on the dam was begun as early as the summer of 1902. The plant was projected by this company to furnish it with electric power, as (notwithstanding its name) it had been buying its power from other parties. In May, 1906, took effect the merger of the Portland General Electric Co., the Portland Railway Co. and the Oregon Water Power & Railway Co. The still uncompleted plant at Cazadero was then taken over by the consolidated company, and it has been completed and put into operation under the new management.

The watershed area of the Clackamas above the power plant is about 900 sq. mi. Its lowest water occurs during the late summer and fall.

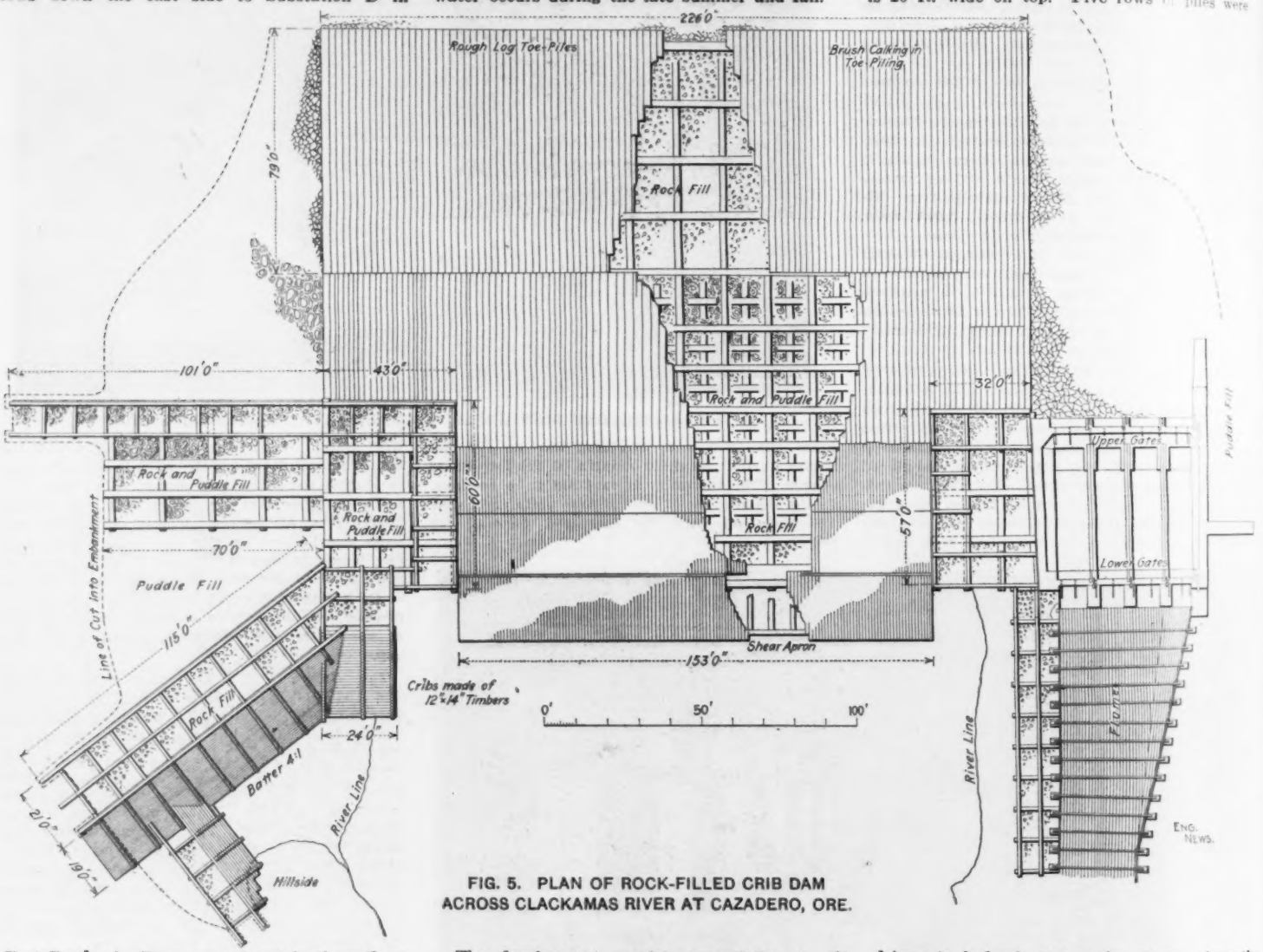


FIG. 5. PLAN OF ROCK-FILLED CRIB DAM ACROSS CLACKAMAS RIVER AT CAZADERO, ORE.

The development consists essentially of: (1) a dam in the Clackamas for raising the level of the water and diverting it into a flume; (2) the flume and canal, which carry the water to the forebay; (3) the forebay, bulkhead and penstocks; (4) the generating station; to these may be added the transformer station and the high-tension transmission line to Portland.

In this locality the river flows between rocky cliffs or steep banks 75 to 100 ft. high, above which there is a nearly level bench of one hundred to several hundred feet in width adjoining the hillsides. The existence of a bench was a very material advantage to an economical power development at this place, as it affords support and space for the canal and the equalizing reservoir. The river has a good fall, about 45 ft. to the mile, through the canyon.

DAM.—The dam is located about 1¼ mi. above the Cazadero railway station. It is of the log-crib rock-fill type (Figs. 4, 5 and 6). As designed it was to be composed entirely of logs forming crib partitions or pockets 10 to 20 ft. square, the pockets being filled with broken rock and clay. The downstream face was vertical, and the upstream face had a slope of about 2 (horizontal) to 1 (vertical). The logs were mostly about 2 ft. in diameter, and they were drift-bolted through at all intersections. The top was not to be planked over, but merely covered with large poles on the upstream slope. This construction proved inadequate, and in the fall of 1905 the east end of the dam was washed out.

In May, 1906, the consolidated company came into possession of the works, and it at once began the work of strengthening and completing the dam and the other parts of the hydraulic works. At the east end was placed a new rock-fill and crib section 120 × 40 ft., founded on bedrock to which it was securely anchored. This section has a maximum height of 65 ft. and is 20 ft. wide on top. Five rows of piles were driven to bedrock across the stream along the upper edge of the old part of the dam. A double planking of 6 × 12 timbers and 2 × 12 plank battens laid flatwise was placed over the upstream slope of the overfall, reaching from the crest upstream for 40 ft. The slope beyond this was covered by a toe-piling, and over all was placed a deep filling of clay and boulders. Large quantities of brush were used in filling around the upstream edges and the ends of the dam, being worked into the clay puddle so as to give a mass more proof against the water cutting through.

As completed, the dam has a total width at base of 176 ft., length on base 230 ft., length over all on top 400 ft. The overall is 153 ft. long between bulkheads, and its crest is 51 ft. above the natural low-water level at this place. The bulkhead or abutment at the east side is 60 ft. long by 43 ft. wide, that on the west side being 57 ft. by 35 ft. In February, 1907, the dam successfully stood a very severe test, a flood in the river causing a depth of 14½ ft. over the overfall crest, within 21 ins. of the top of the

bulkheads. The stage of the river lacked only 18 ins. of being as high as ever known in this locality.

At the west end of the dam are the head-gates for admission of water to the flume. These are set in a small rectangular concrete basin at the outer edge of the bulkhead. There are two sets of four gates each, one set at the upper end and one at the lower end of the basin. Three of the upstream gate openings are 8 ft. wide by 16 ft. high and the other one 10 ft. wide; two of the downstream openings are 8 ft., one 7 ft. and one 9 ft. wide, the height being the same, 16 ft. The object of two sets is to insure the ability to still shut off the water if one set should become inoperative. The gates are of wood, well bolted together. They have bronze bearing surfaces running on steel I-beam slides set in the concrete. They are lifted by spur gear and pinion, engaging rack-bars on the backs of the gates, operated either by hand or by motor.

FIG. 6. THE CAZADERO DAM FROM BELOW; FLUME AT RIGHT.

When the gates are all wide open they provide a means of considerably reducing the flood discharge over the dam. The excess of water entering the flume is wasted over a spillway in the side of the flume just below the dam.

FLUME AND CANAL.—Leading from the head-gates is a flume 2,622 ft. long. The flume is 25 ft. wide by 17 ft. high inside (Fig. 7) and is designed to eventually carry 16 ft. depth of water. It is laid on a grade of 0.05% (1 in 2,000). For the first 2,000 ft. the flume rests on a bench excavated along the canyon side. It follows very closely the ground surface contour, as Fig. 8 illustrates, with the object of avoiding all trestle work, so that it has curves as sharp as 40°. The bench excavation was graded up with a layer of crushed rock, on which the sills of the flume are placed. The flume bents or frames are spaced 6 ft. on centers. The sill is of two pieces of 6 × 12, resting on 6 × 8-in. × 3-ft. mud sills. The foot of each post goes between the two pieces of sill, the post being 8 × 18 ins. × 18 ft. high. The tie at top of each frame connecting ends of opposite posts consists of a 6 × 8 timber gained on and drift-bolted to the posts, and of a ¾-in. steel rod with ends upset to ⅞-in. The bottom of the flume is of a double layer of plank, 3-in. and 2-in., laid to break joints and seams; the sides have both layers at the bottom, with thickness reducing to 2 ins. at the top.

At about 2,000 ft. from the head the flume is sufficiently elevated above the river opposite to

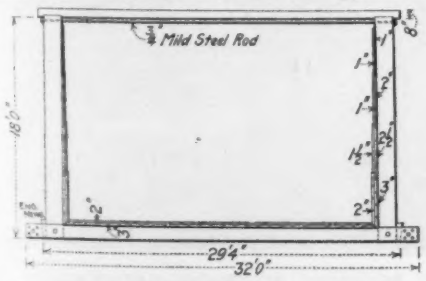


Fig. 7. Cross-Section of Cazadero Flume.

leave the river gorge and run out on the natural bench before described. A heavy excavation is at first required, but the line soon cuts out to an ordinary depth, and then the canal begins. Connection between the flume and canal is made by flaring wing walls of concrete.

The canal has a bottom of 35 ft. wide, and side slopes ranging between ½:1 and 1 to 1. It is meant to carry 16 ft. depth of water and it has a grade of 0.033⅓% (1 to 3,000). The canal is practically in thorough cut all the way, as it is safer than to run near the edge of the bench.

The total length of canal is 2,898 ft. About halfway down the canal there is inserted another stretch of flume of 360 ft. length, used because a great contraction in the width of the bench at this point threw the location nearer the edge of the gorge than desirable. The junction

FIG. 8. A PORTION OF THE CAZADERO FLUME.

between canal and flume at the head of this intermediate section appears in the view Fig 9. The flume here expands to the shape of the canal by means of warped surfaces connecting the vertical sides of the flume with the slopes of the canal.

RESERVOIR AND FOREBAY.—At about 5,900 ft. from the dam the canal opens out into an elongated basin or reservoir. This is about 3,000 ft. long, and it covers an area of fifty acres when filled to an average depth of 20 ft. The reservoir was made possible by reason of the nearly flat bench, and was formed by building an embankment some distance out from the foot of the ascending hillside on the west side.

The embankment was made of clay, gravel and boulders, assorted and placed so as to have the coarser materials on the outside. Part of the material was excavated from the reservoir bed and part was hauled from the hillside excavation along the ditch and flume. The embankment is 20 ft. high at the upper end and 33 ft. high at the lower end (near the penstocks) and its slopes are 2 to 1 and 1½ to 1 on the inner and outer sides respectively. The top width varies with the height, being one-half the depth of water. The reservoir has capacity for supplying about 2,000 sec.-ft. for six hours, its capacity being 43,800,000 cu. ft.

The lower end of the reservoir is fixed by the lower end of the bench, which here almost disappears. To safely draw water off through the penstocks, and also to provide for wasting the excess back into the river, a concrete bulkhead or forebay wall, Fig. 10, is here used. This wall is placed close to the edge of the bench, from which a steep slope leads down to the river.

The bulkhead is of reinforced concrete, 8 ft. thick on top and 20 ft. at the bottom. It has a height of 33 ft. above its foundation; the latter is 47 ft. wide and carried to bedrock, with a thickness of 14 to 16 ft. The wall extends from the lower end of the reservoir embankment by a curved course to the hillside at the extreme end of the reservoir, a distance of 290 ft. Connection is made with the end of the embankment as follows: A core-wall with 4 ft. bottom width and 2 ft. top width extends into the embankment 40 ft. Midway on this core-wall is a pilaster cut-off. From the end of the main wall a heavy wingwall extends into the lake a distance of 79 ft., making an angle of about 47° with the core-wall; selected clay has been used for an earth apron on this.

Near the upper end of the bulkhead are placed the penstock gates. The design calls for five complete operating units, but as but three units have yet been installed, two of the penstock openings have been closed with temporary timber gates. In front of the gates are rack screens. Each of the three penstocks in service is provided with a circular iron slide gate, which can be operated either by hand or by electric power. Near the further end of the bulkhead, next to the hillside, is placed a series of sluice-gates for regulation of the reservoir level to any extent required. These may be seen at the extreme left in Fig. 10.

The penstock openings through the bulkhead are tapering, 9 ft. in diameter at the intake end and 8 ft. at the outer side of the wall. The penstocks are double-riveted steel pipe 8 ft. in diameter, and are from ⅜ to ⅝-in. thick according to pressure. They tap the reservoir at the bottom. For most of their length they are on the steep slope leading down to the power-house. Each one is supported by a concrete longitudinal web-wall giving a narrow bearing under the center of the pipe, with cross walls at frequent intervals. Set on the horizontal section near the head of each penstock is an air pipe, rising to above the level of water in the reservoir. The penstocks pass into the west wall of the power-house, just under the main floor. The static head from the surface of reservoir when full to the water surface in the tailrace at low-water stage is 138 ft.

POWER-HOUSE AND TRANSFORMER STATION.—The power house, Figs. 11, 12 and 13, is of brick with concrete foundations. It is 178× 53 ft. and is well lighted and ventilated. The building has steel roof trusses and composition roof covering. A 20-ton electric traveling crane of Niles make sweeps the length of the building, and a spur of the electric railway runs into the house. There are three units of power installa-

tion at present. Space is provided for two other units, to be placed when increased demand calls for them.

Each hydraulic unit consists of a pair of horizontal high-pressure 42-in. Victor turbines of Francis type. The runners are of bronze cast in one piece. In this type of wheel the water is taken in at the bottom between the wheels and discharged at the sides.

The wheels were made by the Platt Iron Works, of Dayton, O. The ordinary working head is 125 ft., at which each unit is guaranteed to develop 5,000 HP. when using 26,730 cu. ft. of water per min., which gives an efficiency of 79%, the gates being fully opened. For five units running full capacity the reservoir holds a supply of nearly 5½ hours. A Venturi meter is to be placed in one of the penstocks so as to give a record of the amount of water used.

Each unit is equipped with a Lombard vertical type governor. This is provided with a motor for speed control, which is regulated from the operating panel of the switchboard. A Lombard relief valve is also provided, constructed so as not to allow of over 10 lbs. excess in the static pressure at the foot of the penstock. Each set of wheels is provided with a friction brake on the end of the shaft, to quickly bring them to a stop when the gates are closed and the load taken off. The wheels are so placed that the draft tubes give a head of about 20 ft. during low-water.

The three generator units were manufactured by the Bullock Electric Mfg. Co. They are of the revolving field type, have 12-pole fields, run at 330 r. p. m., and generate 33-cycle three-phase current at 11,000 volts. Each generator has a capacity of 2,500 KW. at 100% power factor. On a shaft extension of each unit is a General Electric Co. exciter of 75 KW. capacity.

The main generators were built to fulfil the following specifications: 95% efficiency at full load, 94% at ¾ load and 92% at ½ load; to carry a momentary overload of 100% without injury; and to carry 50% overload for 2½ hours without temperature rise exceeding 45.3° C. The ventilation of armature and field was given especial attention. The revolving field acts as a fan to urge the air through large sized ventilation ducts provided in the armature. Each generator weighs approximately 166,000 lbs., the weight of the largest piece being 40,000 lbs.

The switchboard structure is built so that each high-tension wire is run into a separate concrete compartment. The current is carried from each generator by three-conductor, 15,000-volt, cambric-insulated cable to the oil switches. These switches are of type H-3 of the General Electric Co. They are motor-operated and are controlled by operating switches on the switchboard panels. No high-tension currents are brought to the switchboard. The switchboard panels are of black Monson slate. There are three generator panels, three exciter panels, one line-totaling panel and one panel for station lighting. The panels were supplied by the Stanley-G. I. Electric Mfg. Co.

The generator and feeder oil-switches are mounted in a gallery above the bus bar compartments and in the rear of the panels. There are time-limit relays used in connection with all the oil switches.

The current passes from the power-house across the river to the transformer house. This is a brick building located on top of the bench on the east side. The current is stepped up from 11,000 to 33,000 volts by 850-KW. transformers of Stanley make. These are of the water-cooled type, there being a set of three for each generator unit. Each transformer is located in its own fireproof compartment. The transformers are capable of star-connection with grounded center, giving 57,000 volts between wires, though at the present time the transmission is at 33,000 volts, the transformers being connected in delta.

FIG. 9. WARPED-SURFACE CONNECTION BETWEEN CANAL AND HEAD OF INTERMEDIATE FLUME, CAZADERO HYDRAULIC PLANT.

The outgoing line switches are located in a separate operating room. They are of the Stanley 60,000-volt three-pole single-throw type, and are solenoid operated, the control switches being located on the main switchboard in the power-house. Each outgoing line is provided with 33,000-volt lightning arresters.

TRANSMISSION LINE. — The 33,000-volt transmission line extends from Cazadero to Substation D in East Portland, a distance of 30½ mi. The line follows the general route of the electric railway (owned by the same company) to Barton, about 10½ mi., and also from Sycamore to Lents Junction. When not on the railroad right-of-way it follows the county roads or the city streets, except for a quarter mile, where it uses a purchased right-of-way. The line is in duplicate, the two pole-lines being about 90 ft. apart when along the railway and 40 to 50 ft. when on the county roads. On reaching the city limits, a distance of 23½ mi., the two lines widely diverge.

The poles used up to the city limits are 50 ft. long and have a minimum top diameter of 9 ins. Inside the city they are 60 ft. long. They are all of cedar and are set 6 ft. in the ground. Each pole line carries the three wires of a single circuit. At the top of the pole is a 6 × 6 × 18-in. cross-arm, bolted with a U-bolt, carrying the top wire. The main cross-arm is 4 × 6 in. × 6 ft., bolted with a ⅝-in. bolt and with brace bars below. The arms are of Oregon fir.

Each of three wires or cables is composed of seven strands of No. 8 hard-drawn copper. They are spaced in an equilateral triangle 2 ft. on a side. The insulator used is a triple-petticoat Thomas, of slate-glazed porcelain, for a pressure of 37,500 volts. If 60,000 volts be eventually used, as the wire circuits are designed, a change will be made to much larger insulators. Each insulator is mounted on and cemented to a malleable iron pin. Only one of the two circuits will be in use at any time, the other being kept in reserve, to change over to when necessary.

SUBSTATIONS.—There are no substations between the ends of the high-tension line. There is, however, a separate 10,000-volt line that follows the electric railway and taps into the substations used for its supply. There are five substations, each having transformers and rotary converters for changing to the 500-volt direct current required.

PROJECTED SECOND POWER PLANT ON THE CLACKAMAS.

Early this year work was started by the company on a second power plant on the river, about 2½ mi. above the Cazadero plant and just above backwater from its dam. The new plant will have a higher dam than the lower one, but the head secured will be about the same, and the capacity will also be about the same.

The estimated cost will be about $750,000 as against $1,000,000 for the Cazadero plant, the lesser cost being due principally to the fact that the transmission line already built will convey the current. The time for completion is estimated at about four years.

STATIONS AND SUBSTATIONS IN PORTLAND.

In the district tributary to Portland there are now four generating stations and about fifteen substations. The two hydraulic stations, at Cazadero and Oregon City, have just been described. In Portland are two steam plants. Of these, Station E (including Station C, in an adjoining building) is the most important.

FIG. 10. BULKHEAD OF FOREBAY AT FOOT OF RECEIVING RESERVOIR, CAZADERO HYDRAULIC PLANT.

STATION E.—This is located at Sherlock Ave. and 21st St., in the northwest part of the city; it was put in operation early in 1905. The main building is of brick with steel truss roof. The boiler room is 148 × 61 ft., with an L 36 × 71 ft.; the engine room is 160 × 46 ft. The smokestack is of reinforced concrete 230 ft. high and 12 ft. inside diameter, of the Weber construc-

tion. There are five batteries of Cahall water-tube boilers, each 1,040 HP.

Two kinds of fuel are used, the first being sawdust and sawmill refuse, obtained from two very large sawmills in the immediate vicinity. When refuse (pieces of slab, edging, etc.) is used it is first run through a "hog" and ground down to the proper size for handling by conveyors. This fuel is hauled by team from the sawmills and after passing through the hog is carried to the fuel house, whence it is taken by other conveyors to the boilers, to be fed into the Dutch-oven furnaces, of which there are two to each boiler. The sawdust is brought in on an electric car track on a high trestle by motor and dump car and unloaded directly at the top of the fuel house. The cars are loaded from conveyors at the sawmills, so that no hand work is required on the sawdust.

The second fuel is oil. Each oven is furnished with two Morrissey oil burners, into which

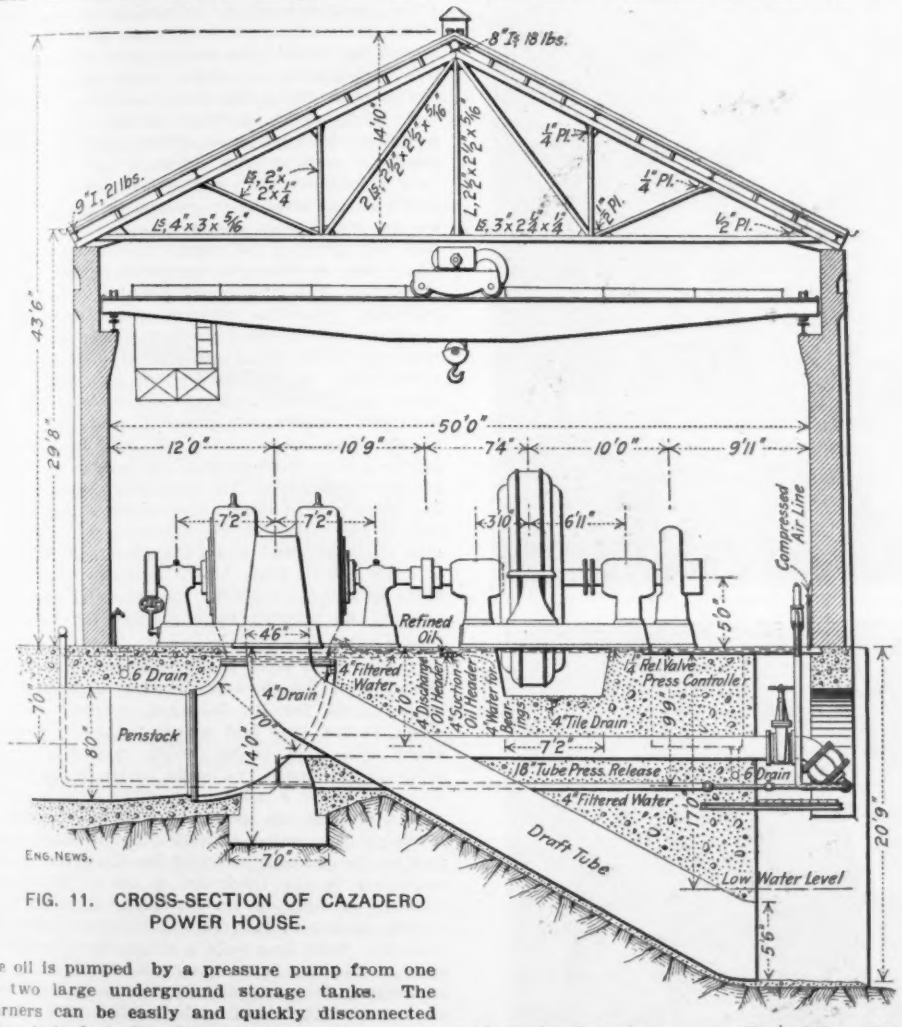


FIG. 11. CROSS-SECTION OF CAZADERO POWER HOUSE.

the oil is pumped by a pressure pump from one of two large underground storage tanks. The burners can be easily and quickly disconnected when it is desired to burn sawdust. A very hot fire is obtained by either method at low cost.

The generating equipment consists of: Two 1,400-HP. marine type compound condensing engines, running at 125 r. p. m., each direct-connected to a 1,000-KW. General Electric 10,000-volt 33-cycle three-phase alternator of the revolving-field type; One 85-KW. and one 60-KW. exciter; Two 1,500-KW. 33-cycle 10,000-volt Curtis steam turbines running at 990 r. p. m., each capable of delivering 2,000 KW. continuously.

The station is equipped with a Shaw 20-ton electrically operated traveling crane.

Station C adjoins E, and is of ordinary corrugated iron construction with wooden truss roof. Its capacity is as follows: Boilers, 3,200 engine-horsepower, engines 3,440 HP., generators 2,150 KW.

The most important substation is the one at Seventh and Alder Sts., near the heart of the retail district of Portland. This is Substation A, the building being 100 x 100 ft. It contains 4,500 KW. capacity in 60-cycle 2,300-volt motor-generator sets; 440 KW in magnetite arc rectifier sets, and 3,600 KW. in 500-volt rotary converters.

An explanation will here be given as to the need of frequency changers, for which motor-generators are used by this company. When the first part of Station B at Oregon City was built in 1893, a frequency of 33 cycles was adopted as the best medium for the mixed load of incandescent and arc lighting, commercial power service and the operation of rotary converters for railway current. Subsequently a frequency of 60 cycles as a standard in lighting and power distribution was adopted. As has already appeared, all of the alternating current generators are 33-cycle 10,000-volt, the more recent following the standards selected in 1893, so that all may operate in synchronism.

There has very recently been completed in East Portland Substation D, which will be the principal substation on the East Side. This is equipped with two 1,000-KW. 500-volt rotary converters; one 1,000-KW. 60-cycle 2,300-volt motor-generator set; and eleven 44-KW. magnetite arc rectifier sets. From Substation A there is a double circuit (10,000-volt three-phase) to Substation D and to Station E, before described, and from Substation D a single 10,000-volt three-phase circuit runs to the suburban town of St. Johns.

DISTRIBUTING SYSTEM IN PORTLAND.

For distribution the city is divided into eleven districts, each of which has a feeder running from a center of distribution to about the center of gravity of use in the district. The primary circuit is single-phase, at 2,300 volts, 60 cycles. The secondary system for incandescent lighting is a three-wire system at 117-234 volts.

In arc lighting, magnetite arc lamps are used for street lamps, the current being rectified by means of mercury tube rectifiers. For commercial lighting, the same circuit as for incandescent lighting is used. The same circuits can be used for alternating current arc lighting, for incandescent lighting, and to supply the smaller power consumers.

There are two power circuits. One is 500-volt direct current, which is used in the downtown section of the city. There is also a three-phase alternating circuit used, the voltage being stepped down to 220 or 440 volts for each consumer. For consumers in scattered districts, power for motors not over about 2 HP. can be taken from the single-phase lighting circuit; for larger motors a three-phase current is obtained by adding the third wire to the single-phase circuit.

On March 1, 1907, there were over 150,000 incandescent lights in use in Portland and vicinity. In arc lighting, there were about 1,350 street lights and about 1,000 indoor arcs. There were also about 2,200 Nernst lamps in use, ranging from 50 to 300 c. p.

In power consumption, for the commercial work there were connections for use of about 15,000 HP., though not all of this load comes on at any one time. For power for the railway service of the company probably 9,000 KW. is used.

SUMMARY OF CAPACITY OF PLANTS.

At the present time the total generating capacity of electrical plants owned by the Portland Railway, Light & Power Co. is as follows:

Station.	Location.	Nature of power.	Capacity.	Current cycles per sec.	Voltage
B	Oregon City	Water	5,730 KW	33	10,000
....	Cazadero	"	7,500	33	10,000
E & C	Portland	Steam	5,000	33	10,000
"	"	"	1,000	0[d.c.]	500
F	"	"	1,700	0[d.c.]	500
Total Portland District,			20,930 KW		
	Salem	Steam	400	60	2,300
	"	"	600	0[d.c.]	500
	Silverton	Water	250	60	2,300
Total Salem District,			1,250 KW		

The Salem district is not electrically connected with the Portland district, and is not included in the foregoing description. Salem is the state capital, with a population of about 15,000. It is located 52 mi. southerly from Portland.

The Cazadero plant was designed by Mr. Geo. I. Brown, Chief Engineer of the Oregon Water Power & Railway Co., which company was building it for its railway and general power purposes. In May, 1906, the uncompleted plant was taken over by the consolidated company. Mr. T. W. Sullivan, who had been hydraulic engineer for the Portland General Electric Co. since 1892 (having superintended the construction of the hydraulic plants at Oregon City) was then placed in charge of the hydraulic installation. This part of the work he carried forward to completion, though making some important changes. The mechanical and electrical installation has been carried out by Mr. O. B. Coldwell, Operating Engineer, while the transmission line was built under the direction of Mr. H. S. Sladen, Transmission Engineer. The three gentlemen named compose the engineering staff of Mr. F. G. Sykes, General Manager of the light and power department of the Portland Railway, Light & Power Co., and to them the writer is indebted for information from which this article has been prepared.

A NEW EMPLOYERS' LIABILITY LAW was enacted by the recent Pennsylvania legislature and has received Gov. Stuart's approval.

The bill provides that in all actions brought to recover from an employer for injuries suffered by his employee the negligence of a fellow-servant of the employer shall not be a defense where the injury was caused or contributed to by any of the following causes: Any defect in the works, plant or machinery of which the employer could have had knowledge by the exercise of ordinary care; the neglect of any person engaged as superintendent, manager, foreman, or any other person in charge or control of the works, plant or machinery; the negligence of any persons to whose orders the employee was bound to conform and did conform, and by reason of his having conformed thereto the injury or death resulted; the act of any fellow-servant done in obedience to the rules, instructions or orders given by the employer, or any other person who has authority to direct the doing of said act. The manager, superintendent, foreman or other person in charge of or control of the works or any part of the works shall under this act be held as the agent of the employer in all suits for damages for death or injuries suffered by employees.

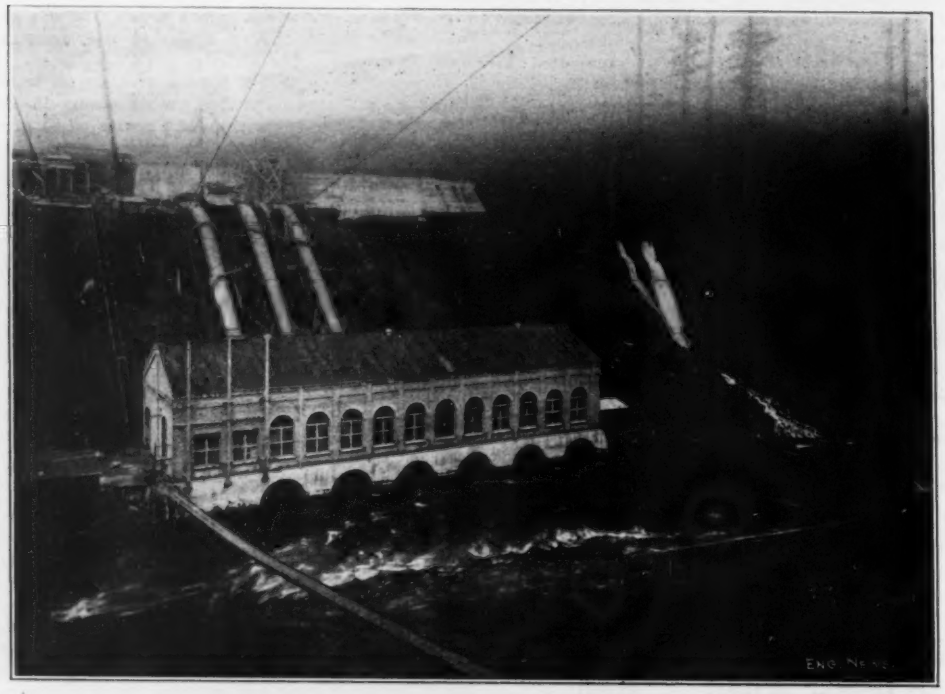
"AUTOGENOUS" WELDING WITH THE OXYGEN-ACETYLENE BLOWPIPE.

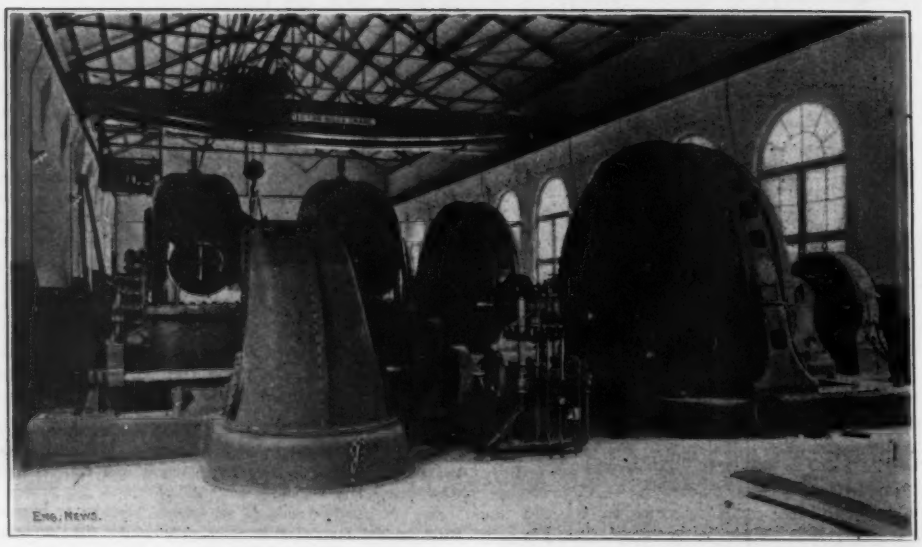
Oxygen and acetylene burning in a blowpipe produce the hottest known combustion flame. The temperature is estimated at 6,300° F., 1,200° higher than the oxy-hydrogen flame and nearly equal to that of the electric arc.

"Autogenous" welding has replaced, in many instances, riveting and brazing processes. It has not always been practical to apply the known methods of obtaining the necessary high temperatures, but the development of the oxygen-acetylene blowpipe has extended the field of this process. Two sheets of metal can be welded by placing their edges in contact and following the same metal as that to be welded, at the same time that the edges are fused. The unfinished joint is stronger than the body of the metal and the finished joint is about the same. Any shaped hole can be easily cut in steel plates up to 6 ins. in thickness, for with the blowpipe the operator can accomplish cutting feats impossible with a saw. In cutting, the kerf is practically the same as if a saw were used.

A plant for autogenous welding with this process has recently been installed by the Worcester Pressed Steel Co., Worcester, Mass. This is the second installation in this country. Some of its interesting features are herein outlined.

The distinctive feature which has done the most to make this welding process of commercial





FIGS. 12 AND 13. EXTERIOR AND INTERIOR OF CAZADERO POWER HOUSE ON THE CLACKAMAS RIVER.

along the seam with a blowpipe. Practically seamless steel and copper tanks of almost any shape and size can be made by forming the body and ends separately and tracing the seams (joints butt and flush) with a blowpipe. The process is especially useful in the foundry, as blowholes and similar defects in castings are easily filled. Cast and wrought iron, steel castings and forgings, copper, brass, bronze and aluminum in many forms of construction are effectively welded either in the manufacture of new parts or in repairing accidental breaks.

To insure strength, the joint is given a slight excess of material by melting a wire or rod of value is the introduction of a new means for producing oxygen. By combining certain chemical products with water, chemically pure oxygen is as easily obtained when, as in uniting calcium carbide and water, acetylene is liberated. The oxygen and acetylene are each generated in a separate apparatus and conveyed through separate pipes to the blowpipe. The oxygen generating apparatus consists of two lead-lined generating chambers arranged with a scrubber and settling chamber between. In making oxygen, one generator is filled with the required amount of luke-warm water to which one chemical charge is added. While this solution is being stirred with an agitator operated by a crank, provided for the purpose, a solution of iron sulphate and water is added which acts as a catalyzer.

The equation of this reaction is rather involved and obscure, and the process somewhat in the nature of a "trade secret." Iron and copper sulphates, with calcium chlorate, yield ferric sulphate, ferric chloride, calcium chloride, calcium sulphate, cupric sulphate and free oxygen.

The oxygen, liberated, passes from the generator through the scrubber and a water sealed trap into the gasometer; from the gasometer the oxygen is compressed to ten atmospheres (147 lbs.) by an air compressor into a pressure storage tank. It is then conducted through ⅜-in. copper piping, from which branches of ¼-in. copper piping lead to the blowpipe connections. Reducing valves are arranged so the operator can vary the pressure of the gas at the blowpipe at will.

The acetylene generator is of the water feed type, composed of a cylindrical shaped tank which serves as a gasometer and regulator, connected by three water supply pipes to three carbide receptacles or trays, half cylindrical in shape, each containing six compartments. Each tray holds about 12 lbs. of lump carbide. The acetylene is used under practically a uniform pressure, varying from 2.2 to 3 lbs. The pressure is obtained and maintained by two water levels in the gasometer, employing the principle of the well-known water column, which automatically governs the supply and pressure of the gas. Any pressure in excess of 3 lbs. escapes through a vent or blow-off outside the generator building. From the regulator and gasometer the acetylene is conveyed through a 1-in. main pipe with one ⅜-in. branch leading to each blowpipe connection. A feature of this acetylene apparatus is a "safety valve" located between the blowpipe connections and the acetylene gasometer. This consists of a 1-in. pipe leading into and two 1-in. pipes leading out from a rectangular metal chamber. The inlet pipe connects with the gasometer. One outlet conveys the acetylene to the blowpipes, the other vents to the outside air. The inlet and outlets are separated by a water sealed trap, which prevents any possibility of ignition reaching the generator and gasometer and burning back through the blowpipe supply pipes.

The blowpipe is of brass construction specially designed on the injector principle and carefully proportioned for its intended purpose. It is about 24 ins. long and weighs 2 lbs. It is provided with two inlets, which remain entirely separate practically the entire length of the blowpipe and enter a mixing chamber with a common outlet at the point of combustion. Each blowpipe is supplied with 22 different sized nozzles, so the size and power of the flame are varied according to the thickness of the metal to be welded. In lighting the blowpipe, the acetylene is first turned on full; then the oxygen is added until the flame has only a single cone. At the apex of this cone is a temperature of 6,300° Fahr. In welding, this point is held from ⅛ in. to ¼ in. distant from the metal to be welded. Too much acetylene produces two cones and a white color; an excess of oxygen is indicated by the flame assuming a violet tint.

Theoretically, 2½ volumes of oxygen are required for the complete combustion of one volume of acetylene. Practically, however, with the oxy-acetylene blowpipe, the best welding results are obtained with 1.7 volumes of oxygen to one volume of acetylene. The acetylene is, therefore, not completely burned with the blowpipe, according to the reaction (1).

$$2\ C_2 H_2 + 5\ O_2 = 4\ CO_2 + 2\ H_2 O,$$

but it is incompletely burned according to the reaction (2)

$$C_2 H_2 + O_2 = 2\ CO + H_2.$$

This is understood when we consider that at the intense heat produced by this combustion the water and carbon dioxide formed by reaction (1) are completely dissociated. To this last fact is chiefly due the success of the oxy-acetylene flame as a welding agent. To establish the proper conditions for autogenously welding two metals

it is necessary to bring them to their melting point without carburating or oxidizing. As shown by the formula, this flame consists largely of carbon monoxide which is being converted at its extremity into carbon dioxide. This, with the hydrogen, forms a relatively cool jacket, which protects the molten metal and the inner cone from loss of heat.

At the moment of initial combustion, when the acetylene is decomposed into elements of carbon and hydrogen, about 300 B. T. U. per cubic ft. of the gas are generated. The total heat, however, generated per cubic ft. of acetylene is about 1,500 B. T. U., which, aside from the initial decomposition, is furnished mainly by the combustion in oxygen of the carbon into carbon dioxide, and in lesser degree by the combustion of hydrogen into water vapor.

Pure acetylene at a pressure of less than 30 lbs., even when passed through pipes at white heat, is perfectly safe; but when mixed with oxygen (or air) is dangerous. An explosive gas mixture enclosed in a pipe does not inflame at once throughout the entire pipe, but from one end of the pipe ignition travels at a certain speed, which increases as the square of the pipe section; therefore to render safe the use of oxygen and acetylene in a blowpipe flame the gas mixture is given a speed by pressure greater than the rate of propagation of the flame.

No flux or molds are required to weld metals such as iron, steel and copper; but for alloys like

Fig. 1. The Oxygen-Acetylene Blow Pipe for Welding Processes; Plant of Worcester Pressed Steel Co.

brass, bronze, etc., a little borax or boracic acid moistened with water is used to prevent the volatilized zinc from being deposited on the joint and destroying the weld. This process welds by fusion, forming a perfect metallic union of the parts which is imperceptible after finishing. It is not brazing.

An operator of average ability can weld steel or copper sheets at the rate and cost for gas approximately as follows:

0.035-in.	(about 1/32-in.),	288 ins. per hr.,	$.0031 per in.
0.062-in.	(about 1/16-in.),	200 ins. per hr.,	$.0065 per in.
0.125-in.	(about 1/8-in.),	120 ins. per hr.,	$.016 per in.
0.377-in.	(about 3/8-in.),	60 ins. per hr.,	$.075 per in.

Metals ¼ in. and less in thickness can ordinarily be welded cheaper than riveted. Steel and copper tanks for high and low pressure of almost any dimensions are effectively welded in place of riveting; broken steel shafts and other forgings repaired, cast iron welded with copper or steel, and blowholes and similar defects in castings and forgings made good.

The Worcester Pressed Steel Co. have accomplished some difficult autogenous welding with aluminum, practically overcoming the trouble from the oxide which forms on the surface of aluminum when exposed to the atmosphere. Although aluminum melts at a comparatively low temperature (1,200° F.), it rapidly conducts and absorbs heat, and requires a comparatively high local heat to obtain the best results. We are indebted to the company for the information here presented.

THE ELECTRIFIED SECTION OF THE WEST SHORE RAILROAD, BETWEEN UTICA AND SYRACUSE, N. Y.: THE ONEIDA RAILWAY.

The electrified section of the West Shore Railroad, under the management of the Oneida Railway, was officially opened for public service on June 15.

The work has been carried out by the Oneida Railway Co., a corporation identified with the

Fig. 2. Welding a ⅜-in. Steel Tank, with the Oxygen-Acetylene Blow Pipe; Worcester Pressed Steel Co.

so-called Andrews-Stanley Syndicate. This syndicate, with the New York Central interests, owns several electric traction properties in New York State, including the Utica & Mohawk Valley Ry., the Syracuse Rapid Transit Co., the Rochester Railway & Light Co., and the Rochester & Eastern Rapid Ry., and also in conjunction with the Delaware & Rudson R. R. Co., the trac-

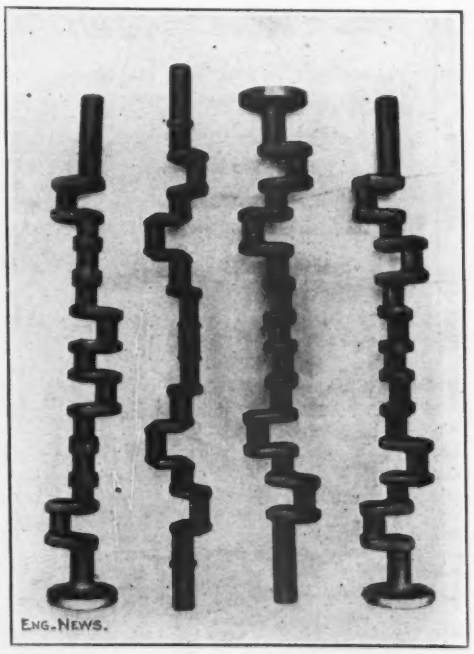


Fig. 3. Welded Steel Crank Shaft Forgings; Worcester Pressed Steel Co.

tion systems in the cities of Schenectady and Albany.

The Oneida Ry. Co. entered into a contract with the New York Central Co. under which the former agreed to lease the tracks of the West Shore R. R., between Utica and Syracuse, equip them for electric operation and conduct the passenger business between these two points. The New York Central on its part consented to abandon the West Shore local trains on these tracks, but reserved the right to continue its through steam trains and to haul freight over the electrified section by steam locomotives. The main tracks of the New York Central R. R. depart from the direct line between Utica and Syracuse and sweep by a long curve to the north through Rome. The electrified section of the West Shore retains the general easterly and westerly direction by a route seven miles shorter than that of the New York Central and extending through a well-populated and rich territory, as shown by Fig. 1.

The distance between Utica and Syracuse is a little over 44 mi., but under the West Shore schedule scant passenger service was provided. Except for two trains with sleeping cars, passing over the line at night and of practically no use to the contiguous or terminal population, there were only two trains each way a day. Among the towns on the new line were Oneida, Vernon and Canastota, having populations respectively of 9,000, 3,000 and 5,000, which should give considerable local traffic. It was decided that the local conditions were well suited to an electric system.

It is proposed to give three classes of service over the West Shore tracks between Syracuse and Utica. First, there will be the fast limited electric cars or trains which will run hourly between the two cities and will make two stops only, completing the run in 1 hr. and 28 min., 28 minutes of this time being used on the local system at each end and one hour for the run between the two cities. Secondly, there will be the local trains or cars which are scheduled to make 24 mi. per hr., and which will complete the run in 1 hr. and 58 min. This service will be run hourly and the cars will make frequent stops, at every highway if necessary. Thirdly, there will be the New York Central steam service.

To provide for passing the fast-moving units around the slower trains, a third track has been laid between Clark's Mills and Vernon, a distance of 8½ mi. This middle track has cross-over connections with both outside tracks and will be used jointly by both east-bound and west-bound traffic, to expedite the movement of all trains. It will be under the control of switchmen located in interlocking switch towers to insure safety and dispatch in the handling of train movements under all conditions. In addition, between Oneida and Canastota, a distance of about 5½ mi., a fourth track has been laid, as there are water stations and freight yards in this section, and it is necessary to provide four tracks to pass the electric units around the freight trains that may be held up in the yards or at watering stations. The outside tracks will be used for the local trains.

POWER TRANSMISSION.

Power for the operation of the line is purchased from the Hudson River Electric Power Co., which owns hydro-electric plants at Spier's Falls and Mechanicsville. The company is now extending its transmission line from these plants to Utica, and expects soon to be able to deliver electric power, at 60,000 volts, to those points.

Pending the completion of these transmission lines, and to fulfil contracts which it had taken for power in the district around Utica, the Hudson River Electric Power Co. has recently erected a temporary steam plant in that city. This station is equipped with steam turbines and is delivering power to the Oneida Railway Co. at 60,000 volts, three-phase and 40 cycles. The contract of the power company provides that it shall deliver this power to the transmission circuit of the railway company, which commences at the Clark's Mills substation, which is that nearest Utica. The power company's transmission line for this distance of 4½ mi. is constructed on a private right-of-way adjoining the West Shore tracks and is carried on two-circuit steel towers, spaced approximately 550 ft. apart. At Clark's Mills the current is taken by the Oneida Railway Co. and is conducted to the three other substations over its own transmission line, which is also built on the private right-of-way of the West Shore R. R. For serving the entire section between Utica and Syracuse,

about 44 mi., there are four substations, as follows: No. 1, at Clark's Mills; No. 2, located 1½ mi. west of Vernon; No. 3, located 1 mi. west of Canastota, and No. 4, located at Manlius Center. The distance between the substations averages approximately 10¾ mi. The transmission line is continuous, being carried into each substation and there tapped to the bus-bar through

This being one of the first 60,000-volt installations in this section of the country, extreme care has been taken to give the necessary clearances on the high-tension side. The layout in general is a typical General Electric layout, the high-tension line entering the under side of a protecting hood at the rear of the building and thence passing through circular openings 3 ft. in

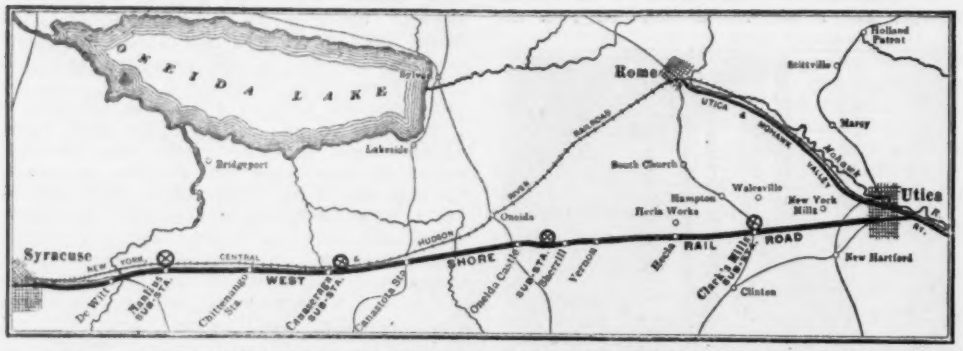


FIG. 1. MAP SHOWING THE ELECTRIFIED SECTION OF THE WEST SHORE RAILROAD.

disconnecting switches, passing out to the next substation.

No. 0, seven-strand, hard-drawn copper cable is used for each conductor. This cable is strung on the towers with a sag of 12 ft. for a 480-ft. span, at 32° F. This sag corresponds to a normal tension of 300 lbs. in the cable. Where the span varies from this length the sag is shortened or lengthened so as to keep the tension in the cable practically constant. Where heavy strains occur, necessitating a double cross-arm, the cable, instead of resting on insulators, is attached to an equalizing saddle to distribute the load equally over several insulators. These saddles are so designed that in case one insulator should be defective it may be removed and another substituted without removing the cable from the saddle. The use of lightning arresters is confined to the substations themselves.

TRANSMISSION LINE TOWER.

The supporting towers consist essentially of a square latticed steel structure composed of four angles, 3 × 3 × 5/16-ins., carried down 5 ft. to reinforced concrete footings under each pier, measuring 5 ft. × 3 ft. × 10 ins. The distance between towers is 480 ft. These towers are figured for a side pressure of the wind of 1¼ lbs. per lineal foot of cable, which is based on a wind pressure of 30 lbs. per ft. on a flat surface, or 15 lbs. per ft. on a round surface, acting upon the cable covered with a thickness of sleet equal to its own diameter. The minimum pull allowable on a single cross-arm tower is 1,000 lbs. for each cable, the ties being designed to break at this tension. The cross-arms of towers at dead ends carry three insulators for each cable and are designed to resist the maximum calculated pull due to the assumed conditions of load and sag.

The heights of the towers are arranged to provide a minimum clearance of 10 ft. over buildings and over such wires as may be crossed by the line. At points where the transmission line makes an angle, the towers are provided with enough insulators so that the cables do not make an angle of over 7½° at any insulator. The general appearance of the towers and their relative position to the track is shown in Fig. 2.

The insulators are of porcelain, made by R. Thomas Sons & Co., of Lisbon, O., and are placed at the corners of a 7-ft. triangle. They are carried on malleable iron pins. 18 ins. high which are designed to withstand a strain of 2,000 lbs. applied in any direction at the top of the insulator. These pins are cemented into the insulators at the factory, and are attached to the apex of the tower or the cross-arm with four ⅝-in. bolts.

SUBSTATIONS.

The four substations mentioned are similar to each other in design. The buildings are of brick with litholite trimmings, concrete roof and floors. They are divided into two main compartments, the high-tension room in the rear, and in front, the rotary converter room.

diameter in the wall of the building to the disconnecting switches and onto the bus compartments.

The high-tension room is two stories in height, the floor being carried only to the face of the barrier walls, which run 3 ft. apart and 3 ft. in depth, up and down the rear wall. This provides a number of cells or compartments open from top to bottom, which are used for the installation of the lighting arresters and bus-bars. The second floor, extending through the room, permits an operator to handle the disconnecting switches, which are located at the top of these compartments. Against the forward wall on the second floor of this high-tension room are built similar barriers forming cells in which are installed the high-tension oil switches.

Three of these cells are required for each switch, one leg being in each. These switches

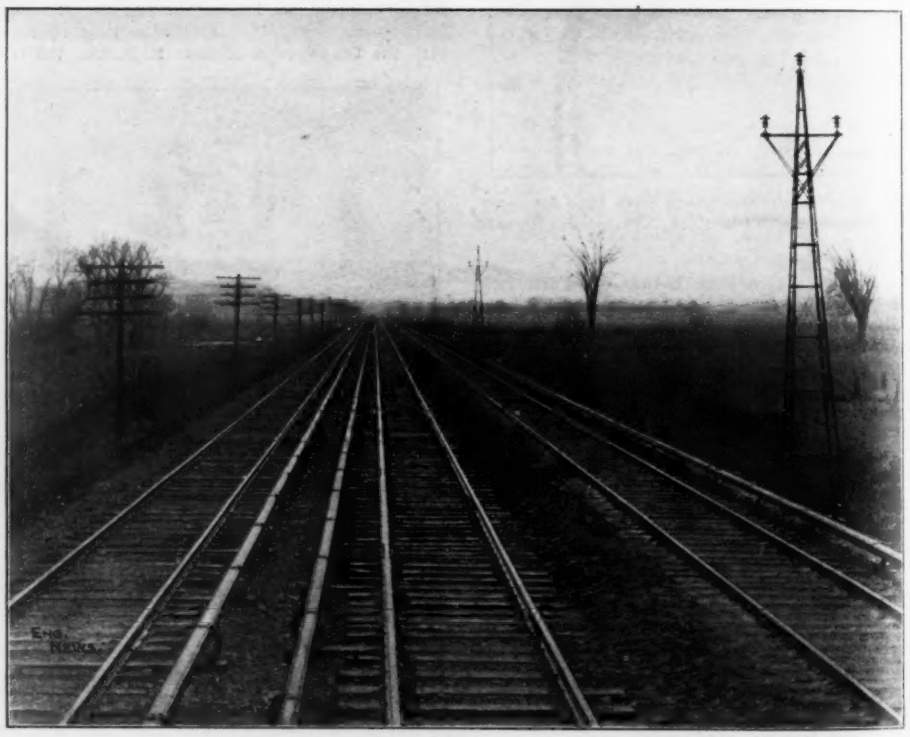


FIG. 2. GENERAL ARRANGEMENT OF TRACK AND TRANSMISSION CONSTRUCTION; ONEIDA RAILWAY.

are motor operated with the mechanism at the top of the barrier. There are three of these in each station except the last, one controlling each of the two machines and one the outgoing high-tension line. The switches are operated by a storage battery from the control board in the converter room. On the first floor of this high-tension room and immediately under the oil switch compartment and running transversely through these barrier walls supporting the oil switches there are three compartments 3 ft. square, one above the other, and extending the length of the room. These are the bus compartments proper and carry the high-tension line through the station. It is from these bus bars that taps are made and carried up to the oil switches. The room is separated from the converter room by fire doors, and the second floor is reached by an iron stairway.

In the converter room are two units consisting of one 330-KW., 60,000:370-volt, oil-cooled transformer, Y connected on the primary side and delta connected on the secondary side, and one 300-KW., 370-volt A. C. and 600-volt D. C. rotary converter. Between the transformer and the rotary stands the reactance which is used for starting the rotary converters.

The switchboard consists of the necessary A. C. and D. C. rotary converter panels, an outgoing high-tension line panel containing ammeters and voltmeter, storage battery panel and the necessary D. C. feeder panels.

TRACK CONSTRUCTION.

The general arrangement of tracks, bed and third rail, shown in Fig. 2, is that adopted by the New York Central R. R. for the electrification in the New York City zone, which was described in a previous issue.*

The density of traffic was not such as to require the great conductivity demanded by the New York Central work and no special composition was used for the third rail. The composition is that used in the standard 70 to 80 lb. rails rolled by the Lackawanna Steel Co. (carbon, 0.45 to 0.55%; phosphorous, not over 0.10%; silicon, not over 0.20%; manganese, not over 0.75 to 1.05%). This gives a resistance of 0.0494 ohms per mile. The conductivity of the rail is that of 1,023,000 circular miles of copper, and is large enough so that no auxiliary direct-current feeders are needed.

The joints in the third rail are made by ordinary two-bolt splice bars with bolts ⅞-ins. in diameter. The center line of the rail is carried 32 ins. outside of the gage line of the track, and its lower surface is 2¾ ins. above the top of the running rail. These dimensions compare with those of the New York Central and the Long Island R. R., as shown in Table I.

The Long Island R. R. dimensions have also

*Engineering News, Nov. 16, 1905.

been employed on the West Jersey & Seashore R. R. The clearance on the West Shore differs from that of either of the others mentioned, but was adopted after a study of the traffic passing over the road. It will permit the passage of all the cars belonging to the New York Central system and all foreign cars except a very limited type of coal cars with low truss rods. Electric locomotives and motor cars designed for use on the Central tracks can also be run over the West Shore tracks without changing the position of the third-rail shoe.

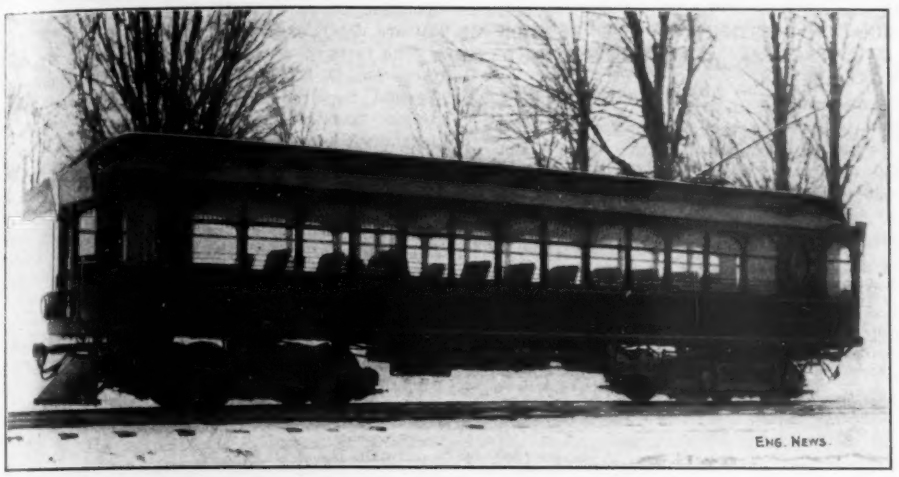


FIG. 3. TYPE OF CAR FOR INTERURBAN SERVICE; ONEIDA RAILWAY.

The third rail is normally located between the tracks on tangents and on the high side of the track on curves.

TABLE OF THIRD-RAIL ELECTRIC LINES.

Road.	Type.	Height of wearing surface above top of track rail.	Horizontal distance between center of third rail and gage line.
Oneida Railway....	Under contact	2¾ ins.	32 ins.
New York Central..	Under contact	2¾ ins.	28¼ ins.
Long Island.....	Over contact	3½ ins.	27½ ins.*

*26 ins. from gage line to gage line.

CONNECTIONS TO THIRD RAIL AND THIRD-RAIL JUMPERS.

The connection between the D. C. bus-bars in the various substations and the third-rail system is made through several cables of 1,000,000 circ. mil. capacity, carried in iron ducts 3 ins. in diameter. The cable is lead incased and insulated with 5/32-in. rubber. The end of this duct at the track is brought up to 2 ins. below the top of the track rail or 2½ ins. above the surface of the tie. Where both third rails are on the inside of the track care is taken to separate the track terminals of the ducts for the east and west-bound tracks by several feet.

The cable, after emerging from the duct, terminates in a T with twisted arms, commonly known as a ram's horn or pig's tail, to each terminal of which is attached a solid terminal for bolting and soldering to the rail. Great care is taken to insulate and protect the cable at the point at which it emerges from the duct by taping and painting with insulating and waterproof paint. The ends of the duct are also plugged with oakum around the cable to keep dirt from entering the duct and to prevent any movement within it of the cable.

The third-rail jumpers used to secure continuous electrical connection between the sections of the third rail are of 1,000,000 circ. mil. capacity and have the same form of ram's horn terminals as the loads from the station to the third rail. The longest gap between sections of third rail is 108 ft., while the distance between shoes of a single car is 29 ft. 6 ins.

At the substation end the connections to the east and west-bound tracks are carried to separate panels on the switchboard so that electrically the east and west-bound tracks are kept entirely distinct except through the bus-bars. In this way an interruption on one track has no effect on the other. The panels in all substations connecting with the same track, however, are in parallel, and no section switches are used. In one or two instances, where there are long sidings equipped with the third rail, as at Clark's Mills, an extra panel has been added to the switchboard to control the current for this section.

CARS.

As the cars are to operate over the city system in both Utica and Syracuse, a different type was adopted than if they were to use the West Shore tracks exclusively. The type is shown in Fig. 3 The main dimensions are as follows:

Length over end panels	40 ft
Length over crown pieces and vestibules	48 ft.
Width over sills (including sheathing)	8 ft.
End sills	6 × 8 ins.
Sill plates	⅝ × 15 ins.
Corner posts	42 ins.
Side posts (2 ft. 9 ins. c. to c.)	2¾ and 4¾ ins.

The bottom framing also carries two intermediate and two center sills composed of 6-in. I-beams extending under the vestibules. The side sills are of wood. The interiors are of inlaid mahogany. The floor is covered with interlocking elastic tile. Storm sash are furnished for the side windows, replacing window guards in winter. The cars are equipped with 24 reversible and two stationary plush seats with high backs and head rolls. Trolley poles are provided for running on city lines at the terminal cities.

Brill trucks are used having a wheel base of 6 ft. 6 ins., a wheel diameter of 37 ins., and an axle diameter of 5½ and 6 ins. The wheel tread is 4 ins. wide and the flange depth 1 in., to allow operation over the Syracuse and Utica city systems.

The installation of the equipment has been conducted by the engineering force of the Oneida Railway, under W. J. Harvie, Electrical Engineer, and M. J. French, Jr., Engineer of Maintenance of Way. Mr. C. Loomis Allen is Vice-President and General Manager of the company. To these gentlemen we are indebted for the information above presented.

RATES FOR WATER SERVICE.*

By DABNEY H. MAURY,† M. Am. Soc. C. E.

The proper fundamental basis for all rates for water service is that the rates, when established, should be fair. In what follows an effort will be made to outline the principles which should govern the determination of the fair rate. As these principles are the same for municipally-owned plants as for private ones, no distinction will hereinafter be made between the two.

Before rates may be termed fair, these two conditions must obtain:

(1) The total yearly receipts from all sources must be just sufficient to provide: (a) Reasonable interest on the investment. (b) Annual contribution to sinking fund to retire investment within a reasonable time. (c) Proper annual contribution to sinking fund for depreciation. (d) Legitimate operating expenses, including repairs.

(2) Each consumer must pay yearly, for the particular class of service that he receives, his just proportion of the above annual costs. To fulfil the second condition, no service of any sort whatever should be furnished free.

*Presidential address before the American Water-Works Association, Toronto, Ont., June 17, 1907.

†Consulting Engineer and Engineer Peoria Water Co., Peoria, Ill.

It may be said that, in practice, neither of these two conditions can ever be realized with absolute exactness, and obviously the second is far more difficult to approximate than the first; but these considerations can in no way affect the fundamental principles involved.

A water-works plant is almost always designed to supply fire protection as well as the water required for ordinary consumption. Manifestly, the first cost and operating expenses of a plant built only to supply water for ordinary consumption are very much less than those of a plant which also furnishes fire protection. An average of available estimates made by eminent authorities shows that the annual cost of furnishing fire protection under average conditions is about 50% of the interest and other fixed charges due to cost of construction of the works, and about 20% of the annual operating expenses. Fair rates would therefore make the receipts from fire protection service sufficient to cover 50% of the fixed charges and 20% of the operating expenses, the balance of 50% of fixed charges and 80% of operating expenses being provided by the rates for water supplied for ordinary consumption.

Fire protection service may properly be divided into two classes: Public Fire Protection, or that provided by the public fire hydrants on the streets; and Private Fire Protection, which is afforded to the owners of factories, stores, warehouses, or the like, by means of special service pipes of large size connected with the water department's distribution mains.

Pursuant to the second essential condition of a fair rate, neither class of fire protection should be furnished free; and the sum of all receipts from both classes should equal the annual expense properly chargeable to the fire protection feature of the works.

In practice, payments for public fire protection may best take the form of hydrant rentals; and whether the plant is municipally or privately owned is wholly immaterial in this connection. In either case the water department is presumably a business concern, operated on a purely business basis; and it should receive the proper rates for public fire protection, paid out of the public funds.

There are abundant reasons why rates should be paid for private fire protection. The owner of the factory or other establishment so protected receives not only a yearly cash benefit measured by the reduction of his insurance premiums, but also a further substantial benefit in the form of protection against loss of business or other fire loss not covered by insurance. This latter benefit, while not so easy to measure in dollars and cents, is often of greater value than the actual reduction in premiums.

The factory owner may argue that the same service connection which lessens his individual fire hazard also lessens to some extent the conflagration hazard of the community; but when all the facts are considered, this cannot well be said to be the case. The openings on his fire protection service are on his premises, and most of them are inside his buildings. They are not accessible for use by other parties. Should he happen to be dishonest enough to do so, he could draw, without detection, large quantities of water for uses other than fire protection. Should a fire once gather headway on his premises, enormous amounts of water might be drawn from thousands of sprinkler heads, or as a result of the breaking of his large service pipes by falling walls, or in other ways; and the quantity of water so drawn might readily be enough to seriously hamper the city fire department in its efforts to check a conflagration. To sum up, the factory owner may be said, in effect, to benefit exclusively, and to a substantial extent, by reason of a special service which the water department is at expense to provide and for which he should therefore pay. It is possible to meter his fire service satisfactorily; and if it were, to base his rate on the value of the water actually consumed to extinguish fires would be as unreasonable as it would be to say that the value of a navy is nothing more than that of the ammunition which it expends in actual warfare.

The fixing of rates for private fire protection is so intricate a problem, and involves consideration of so many points, that no fixed rule can be laid down that will fit all cases. It is believed that a reasonable sliding scale of rates for such service might be arrived at as follows: A minimum rate for the smallest size of fire service pipe, and larger rates for larger service pipes, the rates for each size of fire service pipe to bear some approximately uniform relation to the special benefits derived by the private interests protected.

Rates for water for purposes other than fire protection are of two general classes: fixture rates and meter rates. Originally all water was sold at fixture rates; but the necessity for checking waste, and the recognized inequity of fixture rates, as applied to individual cases, have brought about the introduction of meters, which is now going on at a constantly increasing speed. The earliest fixture rates were necessarily established largely by guess; and later ones have been fixed, sometimes by taking the average and sometimes by picking out the lowest of all the guesses made by previous guessers. Little or no account was usually taken of the difference

in cost of furnishing water in different locations and under varying conditions.

That fixture rates are not now, as a rule, excessive is indicated by the fact that when all legitimate expenses are charged up, few municipally-owned plants earn large profits; and that the securities of private water companies are no longer so eagerly sought by investors as they were some years ago. The objection to fixture rates as a basis of the value of water service does not lie in the fact that they cannot be made, in the aggregate and for any one city as a whole, as equitable as any other rates; for this is not only possible, but is a condition which actually obtains within reasonable limits in many cities. But with fixture rates no close discrimination can be made between individual cases; and they therefore fail to fulfil the second essential condition of a fair rate. Furthermore, they fail to check waste and leakage.

These considerations naturally lead to the adoption of meter rates. In almost every city the introduction of meters, if accompanied by the establishment of proper rates, can be made to result in benefit to the water department as well as to the consumer.

The cost of the introduction of meters and of their subsequent maintenance and operation will, with proper rates, be more than offset, and without hardship to the consumer, by the savings in pumping expenses and in the costs resulting from extensions to plant which would otherwise have to be made.

The function of the meter is twofold: (1) To check waste, and (2) to measure the water used by each consumer, with a view to making his annual payments bear a just proportion to the total fair annual receipts from the works. To treat the meter simply as a device by means of which certain individual consumers may reduce their rates below the fair amount, leaving other consumers to make up the loss, is to defeat its honest purposes.

In order that the meter may properly perform its twofold function, it is absolutely essential that the meter rates be established on a proper basis. In view of the ever-increasing use of meters, no more vital problem to-day confronts the manager of a water department than the determination of what these rates should be in his city; and it is a problem the solution of which demands the highest degree of skill, careful study of all the conditions, and a wide experience in the financial management of water-works.

Nothing is more fallacious than the oft-repeated argument of some unthinking advocates of the universal introduction of meters, that when a man buys water by the gallon he pays for what he gets. Each consumer, whether he uses little or much water, enjoys the benefit of a water service always at hand, always convenient. This benefit is the element which is usually termed the "readiness to serve," and the expense to the water department of its readiness to serve is always far greater than the mere cost of pumping and distributing water. Furthermore, the fixed charges and operating expenses for each meter service amount to several dollars per annum; and this expense, together with a sum sufficient to cover the "readiness to serve," is properly chargeable to each consumer, large or small, before the rate per gallon can fairly begin to apply.

To provide for these two expenses, the first method which naturally suggests itself is the establishment of a minimum meter rate. Here again there is a pitfall. If this minimum be too small it will not accomplish its purpose. If it be too large, or if the rate per gallon for small daily uses be too small, the average domestic consumer may draw far more water than he actually needs without paying more than the minimum rate; and this condition will destroy the usefulness of the meter as a means of checking waste.

To set meters wholesale, without due regard for the foregoing facts, would not only work an injustice to some classes of consumers, but might mean financial disaster to the water department; and this in turn would be a misfortune to the whole community.

To develop the full efficiency of the meter as a means of checking waste, and to make each consumer, large or small, pay his fair share of the total receipts of the work, meter rates should be established about as follows:

(1) The minimum rate should be nearly large enough to provide for the "readiness to serve," as well as for the added expense of the meter service.

(2) There should be a sliding scale of rates for measured water.

(3) The highest rates in this scale should be so adjusted that the average domestic consumer could draw, without exceeding his minimum rate, only enough water for his reasonable requirements, so that the incentive to avoid waste might always be present; and the lowest rates in the scale should be such as to encourage large consumers to patronize the water department, the profits from this patronage being, of course, ultimately applicable to the lowering of rates to all consumers.

From all of the foregoing, it will be seen that rates of all classes are co-related. The total receipts should just provide for the total legitimate expenses, as enumerated in the definition of the first essential condition of a fair rate. Each class of service should be made to furnish its quota of the total receipts from all classes of services; and each individual consumer should pay his just proportion of the total receipts from the class to which he belongs. It is admitted that this ideal state of affairs can never be fully realized in actual practice; but many notable instances of mistakes already made in the establishment of rates furnish abundant proof that a careful, sane and intelligent study of conditions will do much towards approximating the desired results.

EXAMINATION QUESTIONS FOR THE POSITION OF CIVIL ENGINEER AND SUPERINTENDENT OF CONSTRUCTION.

A correspondent in the West sends us a set of examination papers used this spring by the U. S. Civil Service Commission in the examination of candidates for the position of Civil Engineer and Superintendent of Construction. We print the set as follows:

SUBJECT 1.—MATHEMATICS AND APPLIED MECHANICS.

1. A B C is a plane triangle. A B = 31. A C = 45. Angle A = 50°. Find B C.

If vertical planes be passed through the three sides, and another plane intersect the three planes so that Aa, Bb, Cc = 17, 31 and 22, respectively, find solidity of figure thus formed.

2. A Cast Iron Column 15 in. in diameter and 20 ft. high, carries a load of n = 50 tons. Safe working stress of C. I. = 10,000 lbs. per sq. in. Effective load $W = n + \frac{wl^2u}{p^2}$, in which l = length of column in inch, n = 0.003, $p = \sqrt{\frac{I}{A}}$; find thickness to nearest tenth of an inch.

3. A rectangular wooden beam 30 ft. in length, 6 in. in width of cross-section, supported at one end A, and also at B, 6 ft. from the other end, and carries a uniformly distributed load for 10 ft. to the right of A of 200 lbs. per lineal foot, and a concentrated load of 500 lbs. 2 ft. from C, and a concentrated load of 1,000 lbs. 5 ft. to the left of B.

Draw vertical shear diagram, also calculate the maximum bending moment at critical section half way between A and B, also between B and C. Safe unit stress being 800 lbs. per sq. in., what would be the required depth of the beam

$$I = \frac{11d^4}{224} \text{ for circle; } I = \frac{bd^3}{12} \text{ for rectangle.}$$

SUBJECT 2.—THEORY AND PRACTICE OF SURVEYING.

FIRST SHEET.

Answer any Three.

1. (a) Describe in detail an accurate method of measuring the horizontal distance between two points which are not less than one mile apart. (b) To what extent could such a method of measurement be used in a topographical survey covering an extensive area of irregular ground?

2. (a) Describe in detail the location survey for a new pipe line. (b) What do you consider the minimum grades for 6, 8 and 10 in. sewers?

3. Prepare a neat topographical sketch in ink, 3 × 6 in. in size; give scale and append a legend illustrating the meaning of the different topographical signs with which you are familiar.

4. (a) Describe the instrumental work required in making an accurate location on the ground of a long tangent. (b) Define "Degree of Curve."

SECOND SHEET.

Answer Any Three.

5. How do you account for the difference, if any, between "hydraulic head" and the "pressure head" at any given point in a pipe line in which water is flowing? (b) What is meant by "Water-hammer"?

6. Describe the method of computing the volume of earth excavation by means of vertical prisms.

7. (a) State how earth should be deposited in embankments so as to prevent excessive settlement. (b) What should be the maximum side slopes for embankments of the different kinds of material most commonly encountered in earth work?

8. (a) What is the technical definition of the per cent. of grade? (b) What would be the approximate maximum grade for a macadam road, a gravel road, an asphalt pavement, a brick pavement?

SUBJECT 3—BUILDING, CONSTRUCTION, SPECIFICATION, ETC.

Make sketches in ink ¾ in. and 1 ft. scale. Give explanatory note when necessary.

1. Prepare a sketch drawing of a timber trestle highway bridge, showing cross-section and side elevation of one panel, the assumed load and all dimension, including size of timber to be given.

2. Write brief specification for a fireproof floor construction, choosing style of construction that you consider best.

3. Write specification for a basement floor of concrete, describing in detail the method of laying same.

4. Show by sketch a cross-section of a macadam road located along a hill side, giving width, depth of crown and sizes of stones used.

5. (a) Write a brief description of the requisite qualities of good cast-iron water pipe. (b) What material is used in calking the hub and spigot joints of cast-iron water pipe? (c) Describe method of calking.

6. (a) Illustrate by sketch a good method of framing and anchoring the ends of wood floor joists in exterior brick walls. (b) What should be the maximum distance between supports for the different sizes of floor joists commonly used in residences with a spacing of 16 in. centers?

7. (a) Give one test to ascertain purity of white lead. (b) Name some of the adulterants and substitutes used for linseed oil.

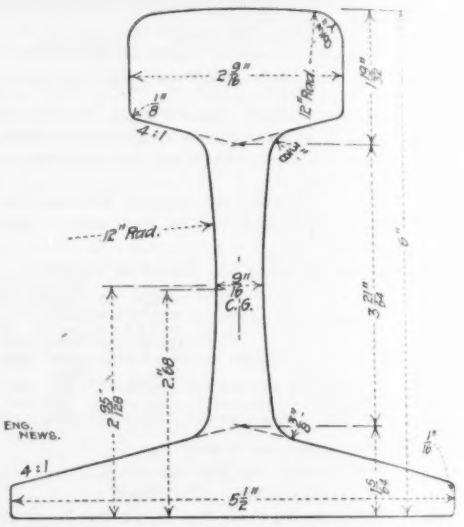
8. (a) What factors are employed in determining the amount of radiating surface required for heating a certain room with steam? (b) What are the advantages and disadvantages of heating a residence with hot water?

A NEW 100-LB. RAIL SECTION.

One of the most interesting recent developments in rail design is the introduction of a new 100-lb. rail section. This has been designed by Capt. R. W. Hunt, M. Am. Soc. C. E., who informs us that it has been adopted by a large railway system As yet, however, no rails of this section have been rolled, and the chemical composition to be used in the rail is a matter for future determination.

The form of section differs materially from the Am. Soc. C. E. type now so generally used. The special features are the narrow head and the thick narrow flange, the latter containing actually more metal than the head. The top corner radius of the head is also larger than usual.

The section is notable in that it has been designed with a view to re-rolling when worn. This process, introduced by Mr. E. W. McKenna several years ago, is now extensively adopted, and worn rails are turned out as new rails of somewhat lighter section. The steel at the same time derives some improvement in quality, as the rolling is done at a comparatively low temperature. It is stated that the new 100-lb. section



New 100-Lb. Rail Section Designed by Capt. R. W. Hunt, M. Am. Soc. C. E.

will stand being twice submitted to this process, finally resulting in an 80-lb. section of similar proportions.

The moment of inertia of the rail section is 48.39. The cross-section is 9.87 sq. ins., distributed thus: Head, 3.56 sq. ins.; web, 2.27 sq. ins.; base, 4.04 sq. ins. The section is shown in the accompanying cut and dimensions are given in the table, in comparison with those of other 100-lb. rail sections and the wide-based 101-lb. section described in our issue of June 13. The conditions of rail design and manufacture at the present time are briefly reviewed in our editorial columns.

DIMENSIONS OF HEAVY RAILS.

Rail section	Hunt.	Am. Soc. C. E.	Dudley. (N.Y.Central Ry.)	A. T. & S. F. Ry.
Weight, per yard	100 lbs.	100 lbs.	100 lbs.	101 lbs.
Height	6 ins.	5¾ ins.	6 ins.	5¾ ins.
Width of base	5⅝ "	5⅝ "	5⅝ "	6⅛ "
Width of head, top	2⅛ "	2¼ "	.....	2⅝ "
Width of head, bottom	2⅛ "	2¾ "	3 "	2⅝ "
Side of head, slope	Vertical	Vertical	4°	Vertical
Depth of head	1⅛ ins.	1⅛ ins.	1⅛ ins.	1⅛ ins.
Height of web	3⅛ "	3⅛ "	3⅛ "	3⅛ "
Depth of base	1⅛ "	⅞ "	⅞ "	1⅛ "
Thickness of web	½ "	½ "	½ "	½ "
Thickness of edge of base	.....	⅛ "	⅛ "	.....
H'ght to c. of bolt hole	2⅛ "	.....	.....	2⅛ "
Radius, top of head	12 "	12 "	14 "	12 "
" top corner of head	⅜ "	⅜ "	⅜ "	½ "
" bottom " "	⅜ "	⅛ "	⅛ "	⅛ "
" top fillets	⅜ "	¾ "	⅝ "	⅜ "
" bottom fillets	⅜ "	⅜ "	⅜ "	¾ "
" corner of base	⅛ "	⅛ "	⅛ "	.....
" sides of web	12 "	12 "	14 "	12 "
Edges of base	Vertical	Vertical	Vertical	Vertical
Fishing angles	4 to 1	13°	14°	18°
Metal in head	36.07%	42%	40.8%	.....
" " web	23.00%	21%	23.5%	.....
" " base	40.93%	37%	35.7%	.....

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.

220 BROADWAY, NEW YORK

BRANCH OFFICES

CHICAGO: 1636 Monadnock Block
WASHINGTON, D. C.: Home Life Building
ATLANTA: Candler Building
RUDOLF MOSSE, BERLIN AND HAMBURG, GERMANY

GEORGE H. FROST, Founder

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Foreign Countries, Regular (Thick Paper) Edition, One Year, $9.00. (£1-18-0.)
Foreign Countries, Thin Paper Edition (Construction News Supplement Omitted), $7.00. 29 Shillings, 35 Francs or 29 Marks. Remit directly to our office.
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Entered at the New York Post-Office as Second-Class Matter.

The question of rail design has of late years become subordinate to that of rail manufacture, mainly because the rail mills have turned out a large proportion of rails whose character ranges from doubtful to positively dangerous. Experiments with new rail sections continue to be made from time to time, however. We describe elsewhere a new rail section of more than ordinary interest, while in our issue of June 13 we described an experimental wide-based rail. In the design and manufacture of rails one of the great difficulties is in the proportioning of metal in the head, web and base, so as to form a section which can be properly rolled and will also give good service in the track. The wide and thin flange or base has always been one of the difficult points, and attempts to make a very wide base in order to increase the bearing area on the ties have been uniformly unsuccessful, as noted in our issue of June 13. It has been shown conclusively that better results are to be obtained by a rail with a base width not exceeding the height, used in combination with metal (or wooden) tie-plates to protect the ties from wear. The new 100-lb. rail noted elsewhere has a comparatively thick and narrow flange, equalizing the distribution of the metal and giving a favorable section for good work in the rolling mill. Another important point in rail design has been to give ample height, to enable the rail to economically perform its function as a girder. A wide head is generally approved, but the idea that a large head would be advantageous is now nearly obsolete, as it is recognized that it must be in good proportion to the other parts of the rail if it is to be properly worked under the rolls so as to give the desired wearing qualities. Within recent years, modifications of the "Am. Soc. C. E." rail sections for the heavier weights of rail (90 to 100 lbs. per yd.) have been suggested, but investigation has shown that there is not sufficient evidence to warrant a change at the present time. The defects in rails to-day are not due to their section, but to the methods of manufacture, and it would be almost useless to expect any improvement from a change in section as long as the mills turn out rails which are so unsatisfactory, and which cause so much trouble and anxiety by their liability to failure in the track. The increased weights of wheel loads and traffic appear to have little influence in causing these failures, as lighter rails made years ago stand up successfully in track where new heavy rails begin to fail almost as soon as they are laid. The railway engineers have vastly improved their specifications within recent years, but as a rule the mills will not accept their conditions, preferring to follow their own methods and specifications, which are not approved by railway engineers who have to use the rails thus produced. Under these conditions the discussion of questions of rail design is at present academic rather than practical.

Flood prevention at Pittsburg and Allegheny has long been a theme of current interest. Hardly a season passes without a period of high water in the Allegheny or Monongahela, which floods the low-lying parts of the cities and causes large financial loss. The newspapers recently have been giving much publicity to the suggestion of some Pittsburg engineer, that the mountainous part of the drainage basins from which these two rivers flow should be planted with forests. While the fallacy of this plan for flood prevention has been again and again explained, it may be worth while, in view of the amount of space devoted to the subject in the newspapers, to point out anew the real facts of the case.

Valuable as a forest cover is for conserving the low-water flow of streams, it has comparatively little effect in reducing the height of floods. The maximum rate of run-off from a given drainage basin in a given period, as every hydraulic engineer knows, will occur at a time when heavy rainfall comes on top of ground that is frozen or is already saturated with previous rains. It was such a rainfall, for example, that preceded the Johnstown flood, in this very drainage basin under discussion. Instances without number are on record where most destructive floods have occurred in regions still covered with primeval forests.

Of course it is true that in parts of the arid Southwest, where large areas of mountain slope exist covered with little soil, the run-off is much more rapid than ever occurs in humid regions covered with vegetation. This fact does not affect the truth of our main contention: that reforestation of the drainage basins in any such district as that of Western Pennsylvania could have no important effect in reducing flood heights.

This number closes Volume 57 of Engineering News, and according to custom, the index to the 26 numbers composing this volume should accompany this issue. We regret to announce that the copy for this index, when nearly ready for the printer was destroyed by an accident and it has been a physical impossibility to reproduce it in time for this issue. Its publication will be necessarily delayed for some weeks. Separate copies of this index will be sent on request, when issued, to any subscriber for the volume now closed whose subscription expires with this number. Others will receive it in due course in connection with a later issue.

The report of the American Society of Testing Materials Convention, held last week at Atlantic City and announced in the bulletin on the front cover, is postponed to our next issue by reason of lack of space in the present number.

BUSINESS AND FINANCE IN 1907; RETROSPECT AND PROSPECT.

Is the prosperity which has prevailed in the United States for some nine years about to end? Does the fall in stocks indicate a coming depression in business? Where are buyers to be had for the bonds which railways and municipalities desire to issue for necessary betterments, improvements and extensions? What causes have brought about the present condition in the security market; and what causes can be looked to to change it?

These questions are typical of those which every intelligent business man is called upon to answer. They are questions which directly affect engineering enterprise of every sort. People go on eating and drinking and wearing out clothes just the same in bad times as in good times—or at least they seem to do so, to the casual onlooker. But the case is very different with the business of the engineer. When the reservoirs of capital dry up—or seem to dry up—new construction has to halt; and the work of the engineer—and to a large extent all engineering industry—is new construction of some form or other.

The first half of 1907, which now draws to a close, has witnessed a great fall in prices of securities—a fall not confined to the United States, but extending, to a greater or less extent, all over the world. There has been, however, no corresponding fall in prices of commodities or of labor. On the contrary, the cost of everything which one buys still remains at a higher point, we believe, than has ever been before recorded.

This means, for one thing, that business is active; that manufacturers in all lines are busy turning out goods for which there is a strong demand. The most distinctive feature of "hard times," familiar to all whose memories extend back over two-score years or more, is mills and factories idle, because there is no sale for their goods; and workmen idle in consequence and unable to spend money in purchases. The slackening of demand and the era of falling prices which precede hard times are not yet evident anywhere. Of course there is in certain lines some falling off from the high-water mark reached during part of last year; and this is to be expected. Some special lines of business have experienced a temporary lull on account of the backward season. But when allowance is made for all these conditions, the fact still remains that industry in this country is highly prosperous at the present time.

Why, then, it may be asked, have stocks had such a fall? Why should a share of stock paying regularly seven per cent., which was worth perhaps 140 a year or so ago, sell now some thirty or forty points lower? If the stock market is, as is often claimed, a barometer of trade, then it is important to know what its changes indicate.

There are times when stocks have fallen because of forebodings of impending commercial disaster. Men who owned stocks have foreseen depression in business and consequent reduced earnings and decreased or passed dividends, and they have offered them for sale. When the stock market falls under such conditions, it *is* a barometer whose warnings should be heeded. We do not believe, however, that the fall of stocks of the past six months is due to any such cause. Rather it is a natural readjustment of stock prices to the current prices of commodities and of capital.

But why, it may be asked, should not the price of stocks rise with the price of commodities? If wheat and beef and land and lumber are all worth more money, why should not shares in productive enterprises be more valuable likewise? In answer to this question it may be said that if stockholders really shared in increased profits, then prices of stocks might well rise with the prices of other things. Rising prices are generally coincident with a general increase in prosperity; and a man who owned a half interest in a manufacturing business would not consider it worth less money as prices of raw material and product rose and profits rose in proportion.

But the fact must be clearly understood that *a high rate of dividend when commodity prices are high actually yields no more to the stockholder than a low rate when commodity prices are low.* The dollar is our measure of value; but it is a measure whose length fluctuates like a yard measure of rubber elastic. The gold dollar is actually worth only what it will buy, and it will buy to-day only one-half to two-thirds as much food, clothing, fuel and shelter as it purchased ten years ago. The man with his fortune invested in 3% bonds ten years ago had actually as large an income to pay his living expenses with as the man to-day has with the same amount of money invested in 5% bonds. If this practical fact is clear, then it ought to be clear that high rates of dividend and high rates of interest are to be expected when commodity prices are high. The low interest rates for money which prevailed during 1894 to 1898 were, after all, as remun-

erative, under the then scale of prices for labor and materials, as are the high rates now prevailing.

Of course it may be said with truth that the fall in value of the dollar affects principal as well as interest, and that a man with a fortune of $100,000 in cash to-day is actually no richer than the man with half or two-thirds that sum ten years ago. That is to say, the man with the smaller amount of money could purchase then as much property in land, buildings, machinery or goods as the man with $100,000 can at the present day.

From this point of view, the price of stocks should rise when commodity prices increase, for the property which the stocks represent is also rising in value. This is in fact what happened during the years from 1900 to 1906. In the latter year, however, prices of stocks rose to a point based on speculative hopes of future increased dividends rather than on actual current earnings; and all the power of Wall Street's bankers could not maintain prices under such conditions.

So much for the influence of the cheapened gold dollar in bringing about the fall in stocks. Let us turn now to the influence of the law of supply and demand.

Our abounding prosperity has created a demand for capital the like of which has never been seen. Manufacturers in all lines have for years been deluged with orders which their mills could not supply. Railways have been at their wits end to get cars enough and locomotives enough to move the traffic forced upon them, and to build tracks enough to hold the cars and move them. Ten thousand new enterprises in trade, in manufactures, in mining, in transportation, appeal to those seeking opportunities for investment. Cities everywhere are remodeling systems of water supply and sewerage, street railways, telephone systems and street paving. From every quarter come these urgent demands for capital.

On the other hand, when we consider the supply of fresh capital, while the profits earned by everyone from the labor to the multi-millionaire are greater now than ever before, yet certain causes operate to make a smaller proportion of them available for investment in fixed enterprises.

To make this rather difficult economic question easy to understand, let us take as an illustration a small isolated community of a hundred people or so. These people may supply their own daily wants in the way of food, clothing, fuel, etc., and in addition in their spare time after completing these tasks they may build themselves bridges or roads or houses, or certain useful labor-saving tools. But it will be evident that the amount of this work they can do in any one season or year is strictly limited. If they are industrious and work long hours, if they eat simple food and dress simply, they may have a large surplus of time left to make permanent improvements. On the other hand, if they are in a barren region where hard work is required to merely procure the means of subsistence, or if they spend their energy on elaborate food and dress, or if they are merely indolent and work only when immediate necessity requires, the community as a whole may have no surplus time to devote to works of permanent improvement.

But what is true of the small community of a hundred souls is true of every other community and of a nation made up of a hundred thousand such communities. *The funds available for investment in any year are limited to what the people of the nation have saved over and above their current living expenses.* The man who spends his entire income, has nothing left to invest; and in a nation of such men one would offer stocks or bonds of profitable enterprises in vain. Labrador furnishes nothing to the world's supply of capital, and neither does Borneo. The people of the one can barely make a living by strenuous exertion; those of the other, besides lacking the advantageous machinery of civilization for multiplying their effectiveness, prefer to spend their surplus time in idleness.

If these facts are clear, then the causes which now restrict the supply of capital for investment should be likewise clear. Our prosperity has begotten extravagance. People earn much more than ten years ago; but they also spend much more on daily living. Higher prices for labor and commodities compel the spending, for one thing, and the wasteful habits that accompany flush times encourage it.

Again, the reduced hours of labor and the diminished efficiency of workmen is one of the most powerful influences in reducing the supply of surplus capital for investment. There can be no possible doubt that this cause alone represents a loss of hundreds of millions of dollars annually to the accumulated wealth of the world. Indeed, if the changes of the past ten years were to continue and the individual workmen were to labor fewer and fewer hours and turn out less and less work in the day, we should inevitably reach a point where there would be no surplus time left to build railways or bridges or water supplies. Our Utopia would then be a close copy of that long existing among natives of the tropics. But long before that stage is reached the pendulum will certainly swing the other way.

It is then a great demand and a limited supply that has brought about the high prices for capital that are now prevailing the world around; and these high prices for capital mean, of course, lower prices for stocks.

The importance of this fact must be apparent, we are sure, to everyone who regards the stock market as a barometer. Investors have not sold stocks because they foresaw financial disaster. They have sold them because at the high prices prevailing last year they could invest money elsewhere to better advantage.

Few investors, we believe, have sold stocks through fear that the Federal Government would deal unjustly with the great industries of trade and transportation. More have sold them because of the revelations of the manner in which leading financiers control these great industries in such a manner as to produce profits for their own pocket all the time. But they have been most influenced to the selling by the eager bidding for their money from all manner of other enterprises. It must be remembered, too, that the great mass of securities of the sound railway and industrial corporations are not bought and sold daily or yearly. A small percentage only floats in the Wall Street maelstrom, is bid up and down by speculators—not always wise or farseeing—and determines the current price of the stock.

We may then conclude that the fall in Wall Street stock quotations of the past six months foretells industrial depression only to the extent that it destroys general confidence in business conditions and thus creates itself the condition which it is currently supposed to indicate. In other words, Wall Street at the present time is not a barometer but a clinical thermometer, which when the patient sees it creates an alarm that produces the fever the thermometer is supposed to indicate.

And now what of the future? With the present activity in all branches of industry, there seems no reason to look for serious loss of business to railways or manufacturers. To the former, some falling off in the volume of traffic will have many compensating advantages, enabling economies to be introduced, operating forces to be improved, betterment work to be carried out with less difficulty. The same things are true of many lines of manufacture. In all lines, projects for improvement will be recast and replanned on the basis of higher prices for capital than have hitherto prevailed. Many projects will be postponed until a renewed demand for bonds enables funds to be secured on a safer and more economical basis than the issue of short term notes.

While the demands for new capital will be adjusted to the supply in this manner, the operation of natural laws will increase the supply of available funds. The general impression that prosperity's continuance may be doubtful is an impelling force toward economy in millions of households. The high prices for capital are an inducement toward thrift which can have enormous influence. If money saved will earn five or six or seven per cent., instead of only three or four, then is there far more inducement to save money, particularly when a dollar spent buys so little in an era of high prices.

In no nation on earth is there anything like the wealth producing power of the United States. None other compares with it in abundance of natural resources, in intelligence and industry of the population and in the extensive use of that labor-saving machinery that has multiplied manyfold the wealth-producing power of civilized nations. It is certain, then, that the enhanced demand and higher price paid for capital will result in a greatly increased supply. And with available capital at hand, a thousand new wealth-producing enterprises will move which are at present only marking time.

THE AMERICAN WATER-WORKS ASSOCIATION.

Not very many years ago we felt it our duty to say that unless the management and methods of the American Water-Works Association were changed for the better, its decline in membership and usefulness would soon bring it to a virtual if not an actual end. Later events have proved that regenerative forces were even then at work. These forces have grown in strength and effectiveness until, as evidenced by the convention at Toronto, last week, they are now dominant. The membership of the association has grown from some 300 to 700; the number of eminently useful papers has been greatly increased; in place of difficulty in getting even a program in advance of a meeting, practically all the papers are now printed and sent to the members weeks before the convention date; the Proceedings are well edited and promptly published; and in general the association is rapidly come to the front as a great national technical society.

Great as has been the progress of the association there is still room for marked improvement. As a desirable minor change, we would suggest that the present boyish plan of nominating members and place of next meeting on the floor give way to letter ballot for the election of members and to choice by the executive committee of the place of next meeting. These methods are now followed by nearly all of the national technical societies. The letter ballot for officers gives every member a chance to vote. Leaving the next meeting place to the executive committee makes it possible to settle that question on its merits, and eliminates the electioneering and speeches of paid agents of "convention city" organizations.

As major changes in the line of growth and efficiency we would suggest a quarterly journal in place of annual proceedings, permanent headquarters in the new Engineering Societies building, in New York City, and, sooner or later, at least two or three winter meetings in New York. All these changes are now more feasible than ever before, on account of the increased membership and the raising of the annual dues from $3 to $5 a year.

As to a quarterly journal, it may be said that the Proceedings for 1907 will include some forty papers, besides committee reports, and bids fair to run to 1,000 pages. Now that the papers are printed and circulated in advance of their presentation, why not distribute this vast mass of printed matter through the year, giving more opportunity for securing discussion and lessening the sand-bag effect of firing a thousand-page volume at a busy water-works man, perhaps at the busiest time of his ever-busy year? The quarterly publication plan would lend itself to the success of meetings through the year, as some of the papers could be presented at these meetings.

It seems a great pity for such an organization as the American Water-Works Association is becoming not to be found among the other national technical societies in the Union building. Just how the association could best utilize headquarters there we will not attempt to say.

We wish to emphasize the fact that the Toronto program was altogether too long and

cumbersome. Nominally scheduled for five working days of eleven sessions, the final session was abandoned in the middle of the week, and the three remaining sessions on the last end of the program were very slimly attended. The convention might almost be said to have ended at noon on Thursday, since after that time a large proportion of the papers were read by title only and many if not most of the few present wished the others were being so treated. This, we believe, indicates the desirability of more frequent meetings and publications, alike.

A commendable feature of the convention was the number of papers dealing with the operation of water-works and with factors in water-works design that make for economy and efficiency of operation.

Many of the papers were short notes on methods employed in meeting accidents or other difficulties, and might well be followed by hundreds of like papers in years to come. In point of length, Mr. Nicholas S. Hill, Jr., outdid all others by his paper on "Tuberculation and the Flow of Water in Pipes." We think no one will begrudge Mr. Hill the credit of having presented the most important paper submitted to the convention; indeed, one of the most important contributions every made to water-works literature. The paper will appeal to all technically trained water-works men and a considerable proportion of the paper will be of equal value to the plain, every-day superintendent—especially if the author's suggestions for lessening the evil effects of tuberculation by scraping mains, and for systematically recording information on the nature and extent of tuberculation and its effects on water flow, be followed.

In some degree supplementary to Mr. Hill's paper were the paper and the discussion on cleaning water mains by scraping. This, as many articles in past numbers of this journal attest, has long been practiced with beneficial results in Great Britain and in a few places in Canada. Why so little of this work has been done in the United States can only be explained, as suggested by Mr. Hill: "Custom * * * burying the distribution system under 4 ft. of earth and forgetting all about it."

A large proportion of the cities of the United States might save immense sums in new construction expenses, for mains and pumps, and large portions of their pumping cost, besides reducing fire risk and loss and improving the quality of their water, if only they would take up the matter of scraping mains with system and intelligence.

Another subject on which many valuable suggestions were made was the choice of pumping machinery, with a view to capital charges and operating expenses, and without undue weight being given to high duty pumping engines.

Water waste, water meters, water rates and water purification came in for a fair amount of discussion, but did not assume such proportions as at many earlier conventions. The secretary intimated that algae growths and their prevention would be prominently before the next convention.

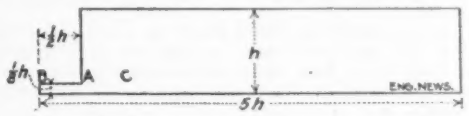
The choice of Washington, D. C., for the next meeting place should result in a large attendance at the convention in 1908. It is to be hoped that some, at least, of the changes suggested above may be given careful attention at that time.

LETTERS TO THE EDITOR.

Web Stresses in a Plate-Girder with Abrupt Change of Depth.

Sir: The writer has failed to find in standard reference works a discussion of plate-girder web stresses at points where sudden changes of depth occur, such as would be applicable to the remarkable case described below. Possibly one of your readers can refer him to such a discussion.

In the design of a plate-girder unusual local conditions render necessary the reduction of its depth, for a certain distance at one end, to about one-eighth the normal depth, as shown in the figure. It is not permissible to bring the upper chord down to A, nor to use a diagonal member or stiffener upward from A. The chord stresses are taken care of by designing the lower chord of such a depth and section that at the end it can be strengthened by adding material to its top and bottom. This reinforced chord B A has a section modulus sufficient to resist the bending moment at A. The additional material



is reduced towards B and continued beyond A to C, being symmetrical about A.

The remainder of the girder is of ordinary design, the only difficult part of the problem being the analysis of web stresses from A to C. It should be noted that under any loading, the longitudinal stresses in the low portion, B A, of the girder are several times as large as those in the normal girder A C.

Yours very truly,

P. Late Girder.

New York City, June 7, 1907.

A Declination Arc on a Transit Plate.

Sir: In "Methods Used in Surveys of Coal Mines," an able article by L. D. Tracy, Assoc. M. Am. Soc. C. E., in your issue of May 30, 1907, Mr. Tracy, in discussing the relative merits of referring mine surveys to the true or the magnetic meridian, says:

The principal advantage of the magnetic meridian, however, lies in the use of the compass as a check against errors while working underground.

Why not have the transit supplied with a declination arc or variation plate for setting off the local declination of the needle? By this means surveys based on the true meridian are as readily checked by the needle as when referred to the magnetic meridian. This simple device is not employed to the extent it merits. Its use in many kinds of surveying is obvious. Particularly it merits attention in topographic surveying for checking azimuths of important readings and in orienting the transit for backsights when occupying new stations.

The writer recently ordered a transit with one row of figures on the plate from 0 to 360 clockwise in the usual way, the other row in quadrants, and the compass ring figured in quadrants as usual, with an additional row of figures from 0 to 360 counter-clockwise. With this arrangement and the local declination of the needle set off by declination arc, any azimuth or bearing referred to true meridian may be checked directly by the needle.

The advantage of the declination arc once common, particularly on "surveyor's" as distinguished from "engineer's" instruments, has been largely lost sight of during the last few decades. The writer has known several young engineers who have never seen a transit so equipped.

Modern methods of topographic surveying bring something of a revival of the use of the needle as a ready means of checking important angles and azimuths, and engineers would lighten their labors and safeguard against mistakes by ordering their transits equipped with declination arcs. A few manufacturers supply this device without extra cost if ordered with a new instrument; others supply it at an extra cost of about $10.

James L. Davis.

New York City, June 7, 1907.

A Proposal for Cooperation Between Makers and Users of Pulverizing Machinery.

Sir: Recently the writer was approached by a gentleman representing a prominent mining paper with the request to write an article on Tube Mills.

I first asked to be excused, but afterwards decided to write an article although not about Tube Mills. There is something of greater importance to both the builder and the user of crushing, grinding, drying and pulverizing machinery, but I doubt whether the papers would allow me the space that such a voluminous article would require.

I therefore would invite the interested parties on both sides to publish their opinions on the subject of a national alliance between the builders and the users of such mills, and only wish to mention a few items which will show the immense value of such combination.

First, it could put a stop to the contemptible bribing of employees by rival manufacturers, which has spread to such an extent that one only wonders why the employers do not notice it.

Second, the necessity of education on both sides. At present the purchaser supposes that the builder of a machine ought to know exactly what his machine can do on a certain material. He does not consider that the builder cannot acquire the knowledge, even if he had the opportunity, as to what his machine can do on the thousands of different materials that are reduced by crushing, grinding or pulverizing machinery, and men in our branch of business know that the reports from customers differ to such an extent that they are entirely unreliable.

I will mention only one instance which occurred in two different departments in one large concern. We sent a mill to Iowa to grind gluten meal and received the report that the mill was utterly useless for the requirements. Only six weeks after this report we received another from the same concern's plant in Glen Cove stating that our mill was the best they ever saw.

As stated before, the papers would prove to be too small for an article which in any intelligent manner would explain all the values contained in a combination of the parties mentioned above.

I am desirous to hear opinions and receive suggestions concerning such a combination and am always ready to assist.

R. F. Abbe.

136 Liberty St., New York City, June 18, 1907.

Friction Coefficients of Wire Rope Drives.

Sir: After reading over the various communications and your comments relating to a wire rope drive problem, in your issue of June 6, the matter resolves itself, in my mind, to a question as to what are the correct premises in the case—whether it is right to assume the coefficient of friction, or to work one out to fit the problem as propounded.

The coefficient of friction in any case will depend on the condition of the rope and the nature of the surface on which it treads. Many years ago, I made some experiments to determine the coefficients of friction of wire rope under various conditions. I hung up three cast-iron sheaves, one with plain groove, one having the groove filled with hard wood, and another having the groove filled with rubber and leather. Over each of these I passed a short piece of wire rope, to one end of which was attached a known weight, and to the other end I applied a powerful spring balance, and carefully noted the force required to slip the rope. I tried this with a dry rope, a wet one, and a greasy one, and it was in this way that I determined the coefficients published in the Trenton Iron Co.'s book, entitled "Wire Rope and Its Application to the Transmission of Power," on p. 23, referred to by Mr. John S. Myers.

My recollection is that it required a somewhat greater effort to start the rope in motion than it did to keep it moving, but no account was taken of the effort at the start, and my calculations were based on the force required to keep the rope moving. The coefficients are as follows:

Dry rope on a grooved iron drum	0.170
Wet rope on a grooved iron drum	.085
Greasy rope on a grooved iron drum	.070
Dry rope on wood-filled sheaves	.235
Wet rope on wood-filled sheaves	.170
Greasy rope on wood-filled sheaves	.140
Dry rope on rubber and leather filling	.495
Wet rope on rubber and leather filling	.400
Greasy rope on rubber and leather filling	.205

I should have tried a rope covered with tar, or with some of the various compounds of tar and crude petroleum, since these substances are most commonly used as a coating for wire rope.

Mr. Charles Kahlerth takes exception to the demonstration of Mr. A. C. Hough, for the reason that he has worked out a coefficient of friction to fit the case. From my figures it is manifest that the coefficient of friction may have a very wide range, and I see no reason for assuming a coefficient of friction, as Mr. Kahlerth has done, corresponding with a favorable condition. I think it reasonable to suppose that in a wire rope drive of this kind a person would apply little, if any, more tension than was actually required to prevent slipping under most adverse conditions, and that in Mr. Grimm's case the necessary counterweight was found to be 800 lbs., or a rope tension of one-half of this, 400 lbs. The coefficient of friction to fit the case, as demonstrated by Mr. Hough, is $f = 0.1004$, which I can readily conceive might be the coefficient corresponding with a wet, tarry rope on an iron surface. Mr. Kahlerth's demonstration is undoubtedly correct from his standpoint, but viewing the matter from the standpoint of a practical man, I should be inclined to accept the demonstration of Mr. Hough rather than that of Mr. Kahlerth, as giving results corresponding with conditions under which the maximum pressure on the bearing occurs.

Irregularities in the stretch of the rope, due to the difference in tension on the incoming and outgoing sides, no doubt produce some back slip, as stated by Mr. Myers, but this is felt principally at the outset. It is well known that a wire rope in a drive through multiple laps will stretch to a greater or less degree, according to the kind of rope and the manner in which it is laid up, and it often happens that a rope has to be taken up once or twice before it finally gets down to its real working length. After this, any slight difference that may occur in the speeds at the incoming and outgoing sides, due to the elasticity of the rope, is a matter that I think has little or no practical bearing on the case.

Yours truly, Wm. Hewitt.

Trenton, N. J., June 7, 1907.

ANNUAL CONVENTION OF THE AMERICAN WATER-WORKS ASSOCIATION.

The twenty-seventh annual convention of the American Water-Works Association, held at Toronto, Ont., last week, was attended by some five hundred or more members and guests and was generally successful. After spirited electioneering, Washington, D. C., was chosen as the place for holding the next convention. Mr. Geo. H. Felix, of Reading, Pa., was unanimously elected as president of the association for the ensuing year, there being no rival candidate. The executive committee acted favorably on 144 applications for membership, raising the total net membership to about 715, against some three hundred only a few years ago.

Many of the forty papers on the program were grouped by subjects, and for convenience still further grouping will be followed in this report, regardless of the exact order in which the papers were read.

THE PRESIDENTIAL ADDRESS.

The address of Mr. Dabney H. Maury, President of the Association, on "Rates for Water Service," is printed in full elsewhere in this issue.

WATER METERS AND WATER WASTE.

Practically the whole of Tuesday afternoon was devoted to the presentation and discussion of three papers on water meters. Mr. Wm. Volkhardt made a stand for the universal meter system. He preferred metering all classes from the start, rather than beginning with a single class, chosen because its members were great wasters of water. If meters are put on all classes friends for the system will be found with the first bills, some of which are bound to be reduced; whereas, the bills of water wasters will be increased and opposition will follow. Monthly meter reading was advocated, even if the bills were not rendered oftener than once in six months, for with monthly readings serious leaks and wastes will be detected before they become of long standing and before bills difficult to collect are incurred.

"The Cost of Meters in Rochester, N. Y.," was reviewed at length by Mr. Geo. W. Rafter. The paper also included statistical and other information regarding water meters and water waste restriction in some other American and in a number of foreign cities. Mr. Rafter's own summary of his paper follows:

(1) The meter department has considerably reduced its running expenses in the last few years.

(2) Statistics in the annual reports not only show that meters do not necessarily reduce the use of water, but in some cases they show the contrary.

(3) The cost of removing, repairing and resetting meters is, as an average for 14 years, $4.80 per meter in Rochester, while there have been 10,883 meters removed and reset during the period.

(4) The cost of setting and testing new meters is, as an average for 14 years, $3.24 per meter in Rochester, while there have been set during the period 11,497 new meters.

(5) The cost of general expense of maintenance of meters is, as an average for 14 years, 37 cts. per meter per year in Rochester.

(6) A meter has to be removed and repaired about once in from 12 to 15 years and the total life of a meter is taken at about 20 years.

(7) A study of the standard meter curve shows that the use of water in Rochester is about as low as it is likely to be, although by metering 100% of the services, the use may be reduced to 65 gals. per capita per day.

(8) At Providence the population supplied with water in 1904 was 207,900, while at Rochester it was 175,000. Total number of services in use in Providence was 23,381 and in Rochester 33,170. Total number of meters in Providence was 20,480 and in Rochester, 12,200. The use of water in Providence in 1904 was 67 gals. per capita per day, while in Rochester the use of Hemlock Lake water was 75.5 gals. per capita per day, which was a decrease of 4.5 gals. over 1903. The increase for the same year at Providence was 2 gals. per capita per day. Hence, there are other reasons for the increase or decrease in use of water besides the use of meters.

(9) In searching for the chief reason, we find that the ratio of inhabitants to number of services in 1904 in Providence was 9.0 and in Rochester 5.2—that is, there were, in 1904, 9.0 persons per service in Providence and in Rochester only 5.2 persons per service. Thus far it has been overlooked that the relation between inhabitants and number of services is an important consideration in the water business.

(10) In Berlin, there is an average of over 70 persons to each service pipe and the daily use of water is only about 20 gals. per capita. The opportunities for waste and leakage are over 13 times as great in Rochester as in Berlin.

(11) In Liverpool, with a density of population of 125 per acre, the use of water in 1901 was 37 U. S. gals. per capita per day. The number of inhabitants per service is about 75. There are comparatively few meters used.

(12) In Manchester, with but 7,000 meters, the daily use of water is about 36 U. S. gals. per capita per day.

(13) The English cities generally do not favor metering.

(14) The number of kinds of meters used in the various cities of this country is large—it would be better to use only one or two kinds in a town.

(15) Other conditions being equal, there will be less water used per capita per day in a town with a large number of consumers per service than in a town with a small number of consumers per service.

(16) The cost of supplying water in Rochester, including the total maintenance account, is $67.75 per million gallons, while the meter rate for selling water is $140 per 1,000,000 gals.

(17) The proportionate part of the consumption of water that is metered in Rochester is 37%, whence the unmetered part is 63%.

(18) The fixture rates in 1904 paid $147,957, while the metered rates, or 37% of the total, paid $277,137. This shows an inequality and injustice between the fixture rates and the metered rates which should be corrected. Had the fixture rates yielded at the same rates as the meters, they would have produced $471,882, and the total income of the water-works, instead of being $425,095, would have been $749,019.

(19) Those water takers who pay meter rates pay 100% profit, while those who take water at flat rates receive it at far less than cost.

Exceptions to portions of Mr. Rafter's paper were made, as noted a little further on.

Mr. James L. Tighe, of Lowell, Mass., treated of "Water Consumption, Waste and Meter Rates." After commenting on the lack of knowledge on the details of water consumption and waste in most of our cities he made some interesting statements regarding water-works practice at Holyoke. Since 1901 the water department, in accordance with a legislative act, has paid a tax on the construction cost of the city water-works. The fire department has paid the water department $8 a year for each fire hydrant in use, and all other city departments have paid the same water rates as are charged private consumers. The supply mains were provided with Venturi and with Premier meters in 1901. After trying a sliding meter scale for large consumers a flat rate was recently adopted: 5 2-3 cts. per 1,000 gals., with a 10% discount for prompt payment. The discount makes the rate 5.1 cts. per 1,000 gals. An extension of the low flat rate to domestic consumers having been advocated, the water department, early this year, set 100 meters on such customers, to determine what would be an equitable flat rate for all consumers.

The superintendent of water-works at Rochester, and also Mr. Geo. P. Fisher, City Engineer, disputed some of the assertions in Mr. Rafter's paper. They pointed out that systematic metering did not begin until 1905, and that the cost of setting and of repairing meters would doubtless be less in the future than in the past, while the effect upon consumption might be expected to be greater. Even a saving of 20 gals. per capita would amount to about $100,000 a year. The cost of about $68 per 1,000,000 gals. of water supplied included no allowance for sinking fund and is based on all water supplied, this including leaks and waste, as well as water for municipal purposes. These facts, with other statements, were advanced to show that the fixture rates in Rochester are not abnormally low.

Mr. W. D. French, of the Hackensack Water Co., which supplies many communities in New Jersey, urged that meters be given more care. His company takes out and tests every meter after it registers set quantities, as follows: ½-in. meter, 100,000 gals.; ¾-in., 250,000 gals.; 1-in., 1,000,000 gals. On testing, these meters are found to run 6 to 7% slow.

Mr. Volkhardt did not agree with Mr. Rafter's statement that it is not worth while to meter more than 50% of the services. This would leave out the domestic consumers, the greatest water wasters. Mr. J. N. Chester said that it might be advisable to stop metering at 50% revenue alone concerned, but the capacity of the works, available supply, etc., must be considered. Mr. R. J. Thomas made a strong plea for a broad view of the question, including not alone revenue, capacity of works and a fair basis of charging for water, but also the economic wrong of wasting a valuable commodity, especially where water is in great demand for power purposes.

A lengthy paper on "The Pitometer and Water-Works Losses," by Edward S. Cole, New York City, was read on Tuesday evening. This paper, which was accompanied by lantern slides, although discussing a number of phases of the subject indicated by the title, was chiefly concerned with the pitometer and its uses in detecting pump slips and water wastage and in recording the amount of each.

PUMPING PLANTS.

Those interested in pumps and pumping engines, whether as designers, manufacturers or operators, could make no reasonable complaint of a lack of papers and of lively discussion on those subjects. Producer gas and electricity as power, and various phases of the relative merits of high and low duty, were considered and in varying degrees extolled, desired, or judicially considered.

Capt. H. G. H. Tarr gave the discussion a pleasant start by alluding to his forty years in the business. He plead for "Greater Economy in Small Pumping Stations," urging that there is far more water pumped and far more coal consumed by so-called steam pumps than by pumping engines. The small triple expansion horizontal pump attains a duty of 100,000,000 ft.-lbs., but its first cost is too great for the amount of water handled. He stated that there was no hope from steam, and then directed his remarks to producer gas, with special reference to the producer gas engine and the centrifugal pump at Poughkeepsie, N. Y. This plant had shown a test duty of 89,000,000 ft.-lbs. had proven economical in operation, and its first cost was low.

Mr. C. A. Hague, in discussion, spoke of the paper as the shadow of prophecy, but expressed himself [as usual on such occasions] as somewhat sceptical regarding the centrifugal pump for high heads. Captain Tarr replied that he did not yet see how with high heads and capacities of 10,000,000 gals. and upwards producer gas could compete with steam.

A producer gas plant and engine, the latter driving triplex power pumps at St. Stephen, N. B., was described by Mr. F. A. Barbour, of Boston. This paper was accompanied by lantern slides, and went into considerable detail. The author promised to incorporate in the paper, before final printing, the results of the official tests of the plant. He gave some figures based on a two-day preliminary run, beginning eight hours after the plant was started up. These showed a pump efficiency of 79%; engine efficiency, 76 to 82%; duty, allowing 2½% slip and making other deductions, 110,000,000 ft.-lbs. The pumps work against a head of 180 ft.

A 25,000,000-gal. electrically driven centrifugal pump at Buffalo, N. Y., was described by Mr. Henry L. Lyon, of that city. The pump works against a 200-ft. head and is driven by a 15-HP. motor. The cost of the pump, motor, transformer and connections was $30,490. The author gave figures comparing the cost of operating this new electrically driven centrifugal pump with the average cost of operating several steam pumps, some of old construction. Adding interest at 3%, electric pumping cost $5.22 and steam pumping cost $4.84 per 1,000,000 gals. lifted to the high service reservoir. The author stated, however, that he did not wish to give the impression that electric pumping was generally cheaper than steam pumping, it being six of one and half a dozen of the other. The printed paper, written some time ago, stated that no repairs had been necessary on the centrifugal pump and that "there is little to repair. The impeller

blades might break, or, in a long use, become worn." It was also stated that during the month previous to writing the paper the Venturi meter on the pump discharge showed a falling off of 3,000,000 gals. a day in registration. The pump was not shut down, owing to the necessity for keeping all the pumps in service during cold weather. On taking the pump apart, quite recently, the impeller was found badly pitted and worn, and attention is now being given to finding a better material for the impeller than bronze.

Mr. W. J. Sando thought the comparison between steam and electric pumping at Buffalo unfair. He was also of the opinion that at a dozen cities in the United States water was being pumped by steam as cheaply as by electricity at Buffalo.

Mr. Chas. A. Hague stated that in the cost-comparisons no allowances for depreciation had been made. He believed that it would be fairer to compare one new steam unit with the centrifugal pump, instead of furnishing all the steam units together. The detailed figures for the steam plant indicated an excessive number of employees.

A paper of 20 printed pages, with a number of insert sheets of tables, was contributed by Mr. Irving H. Reynolds, of Milwaukee. The author not being present, the paper was read by title, only, as follows: "High Duty vs. Low Duty Pumping Engines." The paper stated that:

> For pumps of large capacity, say above 5,000,000 gals., there are comparatively few cases where the low duty machine can be considered, but for capacities up to 3,000,000 to 5,000,000 gals., or occasionally somewhat above, a choice must frequently be made between the two types.

It is necessary to consider each case by itself, and the paper attempted to "call attention to certain of the more important points involved in reaching" each decision, confining itself to reciprocating plunger pumps. After reviewing the various factors involved, in accordance with the foregoing outline, the paper closed by emphasizing the necessity of economy in fuel consumption, in view of the enormous quantities of coal burned each day and the fact that the supply is far from being inexhaustible.

Mr. C. A. Hague, in discussing this paper, suggested 4,000,000 gals. as the limit for compound condensing pumping engines; 6,000,000 for low duty triple expansion; and 10,000,000 for high duty vertical triple expansion.

Mr. Nicholas S. Hill, Jr., said that he was glad to see everyone coming to a sensible, tangible basis for the selection of pumping engines. The choice of a type should depend on local conditions. From the operating viewpoint 100 lbs. of coal was to be preferred as a test basis rather than 1,000 lbs. of steam.

Mr. D. H. Maury agreed with Mr. Hill. He also called attention to the fact that no station works at its full capacity, and that in choosing a pump the normal working time and pumping rate should be considered.

Mr. J. N. Chester took exceptions to a number of points in Mr. Reynold's paper, and stated that his points of difference with Mr. Reynolds were outlined in a discussion of Mr. Reynolds' paper before the St. Louis Engineering Congress of 1903, but that Mr. Reynolds did not reply to his criticisms. Mr. Chester laid stress upon his experience in operating water-works. He stated that in forty plants controlled by the American Water-Works & Guarantee Co., mostly with 5,000,000-gal. units, he did not believe that more than five ran at full capacity and time. He also said that the records of these plants showed low duty pumps to be cheaper in operation than high duty.

At a recent letting, Mr. Chester said, a high duty pump had at first been proposed where the pumps would be idle six months in the year, and at another, where the idle period would be 11 out of 12 months. Officials of municipally-owned plants, with an eye to general appearances rather than close economy, inclined strongly to pumps of high duty. Records had come to his attention where pumping expenses were divided as follows: Fuel, $25,000; wages, $21,000; repairs, $21,000. In such a case it is obvious that a reduction of expenses should be tried elsewhere than in the fuel account.

Mr. W. J. Sando came to the defense of Mr. Reynolds' paper, which he said advocated no type, but merely presented tables based on tests of many engines, by many engineers. He said that operating results, such as Mr. Chester mentioned, had never been published, and suggested that Mr. Chester make his figures available.

Two brief "experience papers" may be mentioned here. Under the title, "A Wheel Pump," Mr. H. F. Dunham, of New York City, told how he had utilized 11 ft. of head in a river to lift water 20 ft. to a sedimentation basin, by connecting a vertical turbine wheel with a centrifugal pump. The body of the pump formed the top of the wheel case.

In the second paper, Mr. E. Forest Williams described the unique means taken at Duquesne, Pa., in the winter of 1907, to operate a pump submerged in a flood 4 ft. in excess of any previous record. The pump was a 1,500,000-gal. compound duplex condensing engine, and was operated under 25 ft. of water. Two large locomotives were placed within about 300 ft. of the pump. Two 2-in. hose were carried down to the top of one of the boilers, from which a 5-in. steam line ran down through 30 ft. of water to the pump. A raft was anchored over the pump, and from this the engineer, Mr. Chas. E. Zimmerman, operated the pump. Water at the rate of 540 gals. per min. was pumped against a head of 423 ft., for some 36 hours.

STANDARD SPECIFICATIONS FOR CAST-IRON PIPE.

A committee on Water-Works Standards, consisting of Mr. Chas. A. Hague, of New York; Theo. A. Leisen, of Wilmington, Del., and W. D. French, of Hoboken, N. J., presented a set of standard specifications for cast-iron pipe. Mr. Hague, for the committee, stated that there were three specifications already in the field: those of the New England Water-Works Association, the U. S. Cast Iron Pipe & Foundry Co., and the American Society for Testing Materials. These specifications had been "brought very close together." Their text was very similar and their tables differed but slightly from each other. The reporting committee considered the New England specifications "very consistent," and the committee had followed them more closely than the other specifications.

The first person to discuss the report was Mr. Allen Hazen, of New York. He said that the New England Water-Works Association never did a better thing than when it adopted its pipe specifications. Doubtless the specifications could be improved, but one and not two standards were desired. The two associations should get together. He moved that the proposed American specifications be printed, with a statement as to how they differed from the New England specifications.

Mr. M. N. Baker, of the editorial staff of this Journal, remarked that one rather than four standards were desired, and called attention to the fact that the specifications under discussion were identical with the New England in wording and arrangement, except for changes at a few points. He thought that these differences should be clearly stated, that like comparisons should be made with the other two specifications named, and, particularly, that the New England Water-Works Association should have full credit for its valuable work.

Mr. Hague remarked that the several specifications were in general accord and that the committee would be glad to point out the differences. Some technical points in the other specifications added to the cost of pipe produced under them.

Representatives of pipe manufacturers having been granted the privilege of discussion, several took the floor. All expressed themselves strongly in favor of a year's delay in adopting the specifications, in order that an agreement on a single standard might be reached. The differences of opinion now prevailing were regarded as capable of adjustment. Mr. Goodhue, of the U. S. Cast Iron Pipe & Foundry Co., stated that a failure to agree with the New England committee was due to the fact that his company, shortly before the conferences with that committee, had just standardized the 14 foundries it had absorbed, and did not wish to make further changes in patterns, etc. Accordingly, it got out its own specifications. He thought that after another year of trial all could come together.

Mr. Leisen, of the reporting committee, thought it commendable rather than otherwise that his committee had adhered closely to the New England specifications. Certainly it was not desired to add a No. 4 to existing "standards."

After several amendments to Mr. Hazen's motion had been proposed and an attempt at a compromise had been made, a substitute motion was carried, by a vote of 32 to 14, to the effect that the committee specifications be approved by the association, and that the committee be requested to confer with those responsible for the three other specifications, with the aim of agreeing on a single standard.

TRAVEL EVENING.

The most entertaining session of the whole convention was on Wednesday evening, when Mr. Allen Hazen gave a lantern-slide talk on "Some Water-Works and Other Views in Australia," and Mr. Geo. A. Johnson presented, in the same manner, "Some Oriental Water-Works." The greater part of Mr. Hazen's views were taken by him during his recent trip to Brisbane, Queensland, to report on the water supply of that city. The views and accompanying talk gave the hearers quite an idea of a part of the world which is little known to Americans. Queensland has an area about equal to that portion of the United States east of the Mississippi River, but its population is only half a million, and a fourth of that lives in Brisbane. The colony is largely devoted to grazing. Butter production is on the increase, but it is difficult to secure labor for corn-raising and for milking. Mr. Hazen showed some views of the new Cataract Dam, just being completed for the water-works of Sydney, N. S. W. (see Eng. News, Dec. 6, 1906), and also some other views taken outside of Queensland.

Mr. Johnson's talk and views related to water-works and to various typical scenes in Japan, and also in Shanghai, Singapore, Calcutta and other cities to the westward of Japan. Some 4,000,000 people in Japan are now supplied with filtered water. Labor in that country is so cheap that no attempt is made to wash the sand scraped from slow sand filters—at least in some of the cities. Instead, new sand is used to replace that removed. An instance was cited where sand was dredged from a river, practically by hand, with ordinary labor at 10 cts. per day.

WATER PURIFICATION.

Numerous practical suggestions on "The Care of a Mechanical Filtration Plant" were presented by Mr. J. M. Diven, of Charleston, S. C. The author stated that "more probably depends on management with mechanical or rapid filters than with the slow filters." The manager of a mechanical filter plant should be properly trained for his work. He should be possessed of good judgment, to enable him to meet the varying conditions of the water he is called upon to treat. The manager of a mechanical filter plant should have some knowledge of both chemistry and bacteriology, as well as of mechanical appliances. Special courses of training at technical schools, to extend over a year or two, were suggested for filter managers. Experts should be called in at intervals to examine mechanical filters, but the great need to be met is for operators who will serve at the rate of $75 a month.

Several points of design bearing on operation were mentioned by Mr. Diven. Convenience should be given first place. Small units are desirable, as best meeting variations in consumption and in other conditions of service, and as throwing only a small percentage of the plant out of service for cleaning. For plants of various sizes Mr. Diven's recommendations as to units were as follows: Under 5,000,000 gals. total capacity, 333,333-gal. units; 5,000,000 to 10,000,000 gals., 500,000-gal.; over 10,000,000 gals., not to exceed 1,000,000-gal units. Preference for gravity coagulant feed was expressed,

since with it the working parts of the feeding devices can be of hard rubber and of lead, thus avoiding the wear on the metals necessary for coagulant feed pumps.

Sterilization by live steam and soda ash was strongly urged by Mr. Diven. In this connection, a long-stem thermometer should be provided, so as to ensure bringing the sand in the filters to the boiling point and keeping it there for two hours.

This paper was discussed by Mr. J. N. Chester, who stated that he preferred as a filter operator a pumping engineer or other intelligent man capable of taking and acting on instructions from an expert, and also capable of studying up his duties by the aid of books. The practicability of this plan had been proven by the American Water-Works & Guarantee Co., of Pittsburg, with which Mr. Chester was formerly connected. A number of these men, he claimed, had really become competent chemists and bacteriologists [presumably for a limited range of determinations.—Ed.]

"The St. Louis Method of Purification" was described by Wilson F. Monfort, chemist of the water department of the city. The old settling basins at St. Louis have been adapted to the use of lime and sulphate of alumina as a coagulant (see Eng. News, Oct. 27, 1904). The river water thus treated has shown a turbidity range of more than 2,000 parts per 1,000,000 within five months, with a maximum of 3,600 and average, for a year, of 1,200. The sediment has run as high as 5,300 parts per 1,000,000; alkalinity, 63 to 176; color, 25 to 71. The combined effect of coagulation and some days of sedimentation has been heavy reductions in turbidity, alkalinity, color and bacteria. Using iron at the rate of 2.13 grains per gal. and lime at 7.4 grains, the cost per 1,000,000 gals. of water treated has been: iron, $1.44; lime, $2.45; labor, $0.60; power, $.06; repairs, etc., $.08; total, $4.62.

The efficiency of the lime has been increased by using hot water for slaking. Apparatus has been designed for utilizing the heat generated by slaking to heat the slaking water, a coil being employed for the purpose.

Some experiments on water softening, made at the State Laboratory of Hygiene, University of Illinois, were described by Prof. Edw. Bartow. Lime, caustic soda, soda ash and a combination of soda ash and lime were the agents used on waters containing bicarbonates and sulphates. The author suggested that water-works having water needing treatment should ascertain the best method of softening to meet their local needs, even if a softening plant was not installed, since consumers could then be advised how to treat the water to prevent boiler scale.

The use of copper sulphate to prevent trouble with algae at Middletown, N. Y., was described by Mr. T. W. Davey. Mechanical filters were installed in 1900, but algae growths continuing an effort was made to lessen the trouble by deepening the water near the shore of one of the reservoirs and by stripping some of the bottom. This not proving effective, copper sulphate was tried in 1904, on the advice of Mr. James M. Caird (see Eng. News, Jan. 12, 1905). This reservoir was treated again in 1905 and in 1906, and in the latter year one of the other reservoirs was treated.

VARIOUS PHASES OF THE QUALITY OF WATER.

A number of short papers relating to the quality of water were read. The first of these, by Prof. W. P. Mason, described the contamination of a well by gasoline. The well was located near Wallingford, Conn., at an anti-tuberculosis colony. It was about 66 ft. deep, in red sandstone. A 500-gal. gasoline tank, of riveted steel, 3 ft. in diameter and 10 ft. long, was placed just below the surface of the ground, 130 ft. from the well. The tank had been tested to 5 lbs. of air pressure. Gasoline engines were located within 100 ft. of the well. About a month after the engines were started the well water tasted strongly of gasoline. An examination by Prof. Mason showed that several hundred gallons of gasoline had run out or into the soil within 100 ft. of the well. Prof. Mason advised that the well be abandoned, as it was not likely that the taste would disappear in a reasonable length of time. After three years the gasoline could still be tasted.

On the conclusion of the paper, Mr. D. H. Maury told of a health officer in an Illinois town who, to convince the citizens of the necessity of water-works and sewers, had a gallon of kerosene dumped in every cesspool in town during the night. The relation between the cesspools and wells was thus conclusively established.

Another paper by Prof. Mason dealt with "The Action of Water on Lead and Zinc." After describing this action, the author suggested the desirability of testing a prospective supply to determine in advance what the action would be, as follows: Immerse 1 sq. decimeter of bright lead or zinc plate in 1 liter of water for 1 hr., the water to be at a temperature of 15° C. The metal should be slightly moved a few times during the test. If the metal has an area of 1 sq. decimeter on each side then 2 liters of water should be used.

Mr. James M. Caird, of Troy, N. Y., presented a paper on "The Possibility of Water in Mains Under Pressure Becoming Polluted from External Sources." The author had never been able to detect pollution of water in a submerged main, by either chemical or bacterial tests. Through the courtesy of Mr. J. M. Diven the author made a special test to throw light on the possibility of such contamination. A ¾-in. service pipe was passed through the bottom of an iron tank 4 ft. in diameter and 12 ft. high. The normal static pressure in the service was 45 lbs., but this was reducible at will. With the full pressure in the pipe, the tank full of water and overflowing and the service pressure finally reduced to 9 lbs., a heavy dose of permanganate solution in the tank caused no discoloration in the discharge from the service. With slightly more pressure outside than inside the service pipe, color appeared in the discharged water. Negative results were obtained by dosing the tank water with common salt, and reducing the service pressure from 54 to 42 lbs. It should be made clear that a leaky pipe was simulated and the reduction of pressure within the pipe was affected by means of a ½-in. valve on the service, within the tank.

"The Sanitary Protection of Surface Water Supplies" was dealt with at length in a paper sent by Dr. Geo. A. Soper, of New York. The author stated that unavoidable typhoid epidemics of note which had occured in the last 24 years, beginning with Caterham, England, and ending at Butler, Pa., had resulted in more than 14,000,000 cases of the disease, with 1,142 deaths, in a population of about 600,000. He dealt with measures of systematic protection of surface supplies under eight heads: (1) Purchase of the drainage area, which is generally not feasible except for strips around reservoirs, and which rarely gives full protection; (2), sewage treatment plants; (3) domestic sanitary arrangements at country houses, stables, etc., and also the drainage of highways and railways; (4) care of the sick and their discharges; (5) regulation of ice cutting, bathing and boating; (6) water analyses; (7) inspections; (8) office work, maps and records.

THE TUBERCULATION AND THE CLEANING OF WATER MAINS.

A monograph on "Tuberculation and the Flow of Water in Pipes" was presented in abstract by Mr. Nicholas S. Hill, Jr. It filled 70 printed octavo pages, and was accompanied by numerous tables and diagrams. The author, in opening, made the pertinent inquiry: how long will "water-works engineers and superintendents bury their distribution systems under 4 ft. of earth and leave them to rust, corrode, fill up and putrefy, without means of access for inspection or cleaning?" He then reviewed at length the nature and cause of tuberculation, presented formulas and tables for the flow of water in pipes, gave analyses of scrapings from pipes, submitted a standard sheet for reports on cleaning and testing water mains, and gave the results of various observations on the hydraulics of water mains after varying periods of service.

A paper by Mr. Park Woodward, of Atlanta, Ga., gave a few facts about cleaning some 6-in. and 30-in. mains in the city named. The work on the 30-in. main, which was done by contract, increased its capacity by 45% and obviated laying a duplicate main, 30,000 ft. long. The paper gave no cost figures.

Mr. Geo. F. Whitney, of New York City, a contractor engaged in cleaning water mains, outlined work done by him in various cities, with the percentage results of increased flow and pressure. He also dwelt upon the obvious advantages of cleaning mains, which include, besides increased volume and pressure, economy in cost of extensions and, in many works, a reduction in pumping expenses. Corporation cocks are not disturbed by the cleaning machine, not even driven cocks, nor is there any injury to gate seats.

REPAIRING BROKEN SUBMERGED WATER MAINS.

A paper by Mr. Harry A. Lord, of Ogdensburg, N. Y., told how he repaired a break in a 12-in. submerged cast-iron pipe line, which had Ward flexible joints. The submerged pipe was 350 ft. long, and was laid on the rock bottom of the river in a normal water depth of 8 ft. After seven years of service without mishap an ice jam broke a single length of pipe at a joint. The current was very strong and the ends of the ruptured pipe were 15 ft. apart. Following, in reverse order, the method employed by Mr. Ward in laying the pipe in 1898, the pipe was disconnected at the shore ends, and then pulled ashore by means of horses, a capstan, block and tackle. The joints were melted out with kerosene heaters as they came ashore. The disconnected pipe was cleaned, treated with waterproof metallic paint, reconnected, and then hauled back to position. A test showed that it was tight.

Mr. C. W. Wiles, Delaware, O., told how he repaired a broken submerged 16-in. cast-iron main, which had apparently been broken by the fall of the capstone of a large nearby culvert that washed out during a flood. A piece about 5 ft. long was broken from the pipe. After the flood subsided, the next morning, the water over the pipe was about 3 ft. deep. The broken length was blown out with dynamite, the pipe each side of the break was uncovered for 40 ft., the two broken ends were lifted out of the water and forced to one side, and a new 12-ft. length inserted and caulked. The job was completed within 24 hours, including the transportation of men and materials 2½ miles.

PRIVATE FIRE PROTECTION SERVICE.

As usual, this topic brought out many strong protests against the stand of the fire underwriters on most phases of the subject. The first paper read, by Mr. A. W. Hardy, was from the underwriter viewpoint, but was more impartial than some papers on that side of the question. Mr. Park Woodward, of Atlanta, and Mr. Albert H. Wehr, of the Baltimore (Md.) County Water & Electric Light Co., sent papers embodying the rules of their department and company, respectively, governing private fire service. Mr. J. M. Diven described an indicator meter, placed on a by-pass, which he had used on private fire services while at Elmira, N. Y.

Mr. D. H. Maury, in discussing the paper, condemned using fire hydrants provided with nozzle gates. These generally have small stems, which, on being operated with the ordinary long key, are frequently broken off. He knew of a big hotel fire where two stems on a three-nozzle and five stems on a six-nozzle hydrant were broken by the firemen in turning on water. Mr. Maury agreed with Mr. Hardy that the factory sprinkler system should be regarded as a first aid; but it should not be supplied through a main large enough to operate the whole sprinkler system. Mr. Maury cited numerous instances where water had been stolen through private fire protection systems, and he asserted that the underwriters lay down requirements for the express purpose of serving as a basis to raise fire rates, because of non-fulfilment. This course, he said

had been followed to recoup the insurance companies for heavy losses after large conflagrations. A number of other members were emphatic in their declarations of the abuse by consumers of private fire protection privileges. Practically all agreed that there must be a check, in the way of meters or otherwise, to prevent stealing water. A majority seemed to be in favor of charging for private fire protection service.

OTHER PAPERS.

There was a total of 37 papers on the program, and several volunteer papers came in during the convention. Many of the papers not already mentioned were read by title only, and few or none of those not spoken of above were discussed, largely through lack of time. The final session, scheduled for Saturday, was omitted, and the afternoon session of Thursday and both sessions on Friday were very slimly attended.

Mention of the following additional papers may be made: "Notes on Rules, Ordinances and Court Decisions Governing the Operation of Water-Works," S. J. Rosamond. "Proper Rates for Water Supply," John Ericson. "Dousing," Chas. Anthony, Jr. Three papers on personal water-works experiences by L. N. Case, H. L. Williams and John F. J. Mulhall, respectively. Mr. Mulhall's paper dealt with accounting. His death was announced when the title of his paper was read. "An Effective Follow-Up System for Complaints," by Albert H. Wehr. "Plan for Interchange Between High and Low Pressure Systems, at Buffalo, N. Y.," by Henry L. Lyon. "The New Discharge System at Spring Avenue Pumping Station, Chicago," by W. A. Severing and H. S. Baker. In connection with this paper it was stated that in one year 175,000,000 gals. pumping capacity was added to the Chicago water-works, making a total capacity of 652,000,000 gals. "How Can Politics be Eliminated from the Management of a Municipal Water-Works," by J. M. Diven. Mr. Diven suggested that local water-works choose delegates to state conventions and that these in turn choose delegates to a national convention; or, virtually, that state and national commissions, controlling water-works and sewers, should be formed. A number of speakers advocated a national board of health. Several members considered existing state boards of health incompetent to deal with water-works and sewerage matters, because such boards are composed mostly of doctors, who are very poorly informed on engineering subjects.

MISCELLANEOUS MATTERS.

During the convention 126 active and 18 associate members were formally added to the membership list, making a grand total of about 715 members. Hon. John Galbraith, Dean of the Faculty of Applied Sciences, Toronto University, was elected an honorary member. The annual dues were increased from $3 to $5.

GRADE CORRECTION AND PILE FOUNDATIONS IN THE EAST RIVER TUNNEL OF THE NEW YORK RAPID TRANSIT SUBWAY.

The novel expedient of putting a pile foundation under a subaqueous tunnel in order to ensure its permanent stability under traffic, first projected for the Pennsylvania R. R. tunnel under the Hudson River at New York City, is at present being applied to the East River tunnel of the New York Rapid Transit Ry. In effect this gives the latter tunnel, commonly known as the Battery tunnel, priority in the actual use of pile foundations; for in the Pennsylvania tunnel only one pile has been driven as yet, and that merely for experimental purposes, while something over twenty foundations have been put down in the Battery tunnel. The conditions under which this work was decided upon and carried out are unusual.

Profiles of the two tubes of the tunnel are given in Fig. 1, where are noted also the several kinds of soil passed through. At the Manhattan end both tubes of the tunnel start in solid rock, mica schist and gneiss. They remain in this material to a point near the middle of the river, where the rock surface dips downward rather sharply. Fine sand is then encountered, but after about 600 ft. the tunnels again strike rock, which rises up as a reef some 400 ft. wide. Beyond the reef soft soil continues to the Brooklyn end of the subaqueous tunnels. For five or six hundred feet east of the reef, this soil is fine sand and clay, then it changes to coarser sand, and nearer the Brooklyn shore it becomes a mixture of sand and gravel. The material here called "fine sand and clay" is what has given the greatest amount of trouble in the construction of the tunnel. It is in effect a quicksand, flowing rather freely when it contains water in motion, but stable and firm when confined or when free of excess of water.

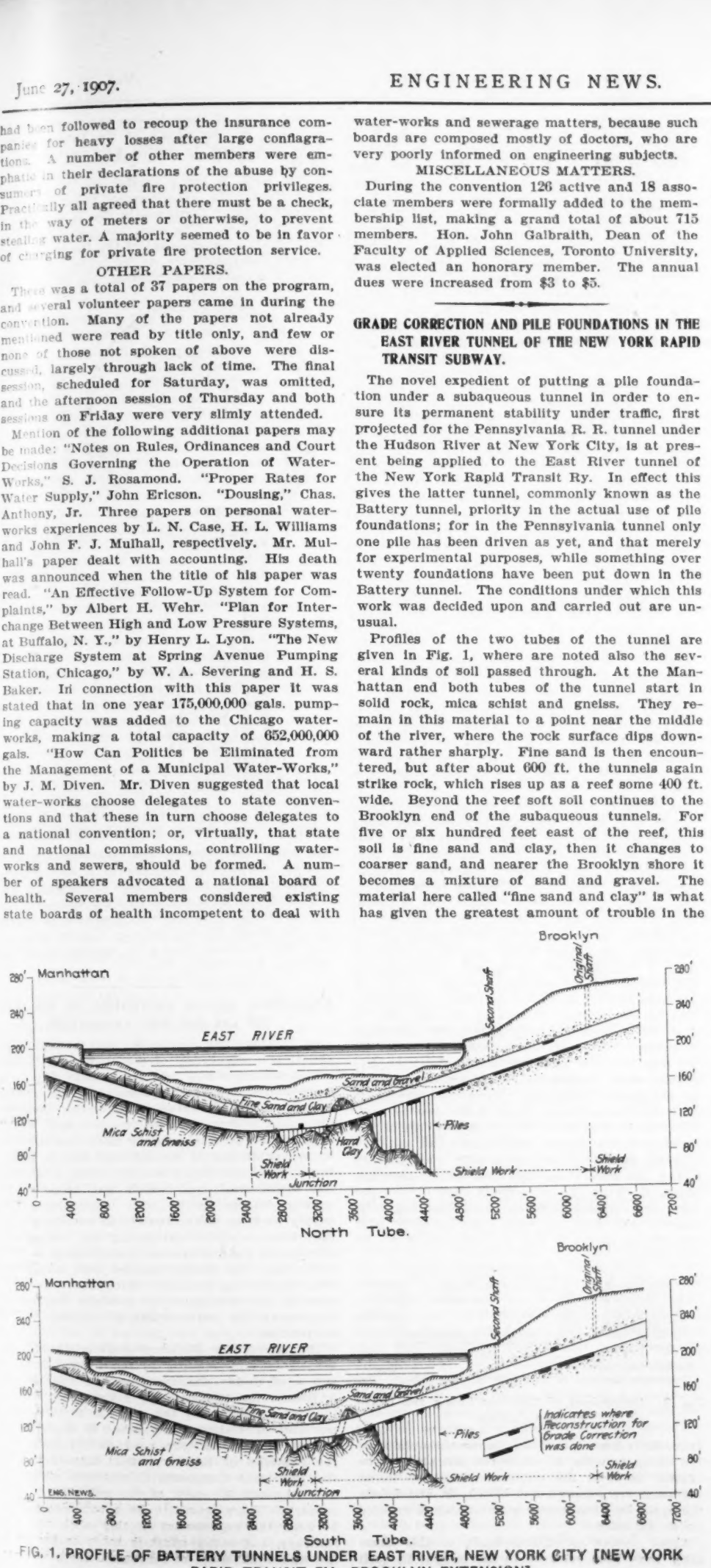


FIG. 1. PROFILE OF BATTERY TUNNELS UNDER EAST RIVER, NEW YORK CITY [NEW YORK RAPID TRANSIT RY., BROOKLYN EXTENSION].

The Battery tunnel consists of two separate tubes of circular section (Fig. 2), lined with bolted cast-iron sectional lining (Fig. 3) of the usual type. Its diameter over outside of lining is 16 ft. 8½ ins., and as the flanges of the lining are 7½ ins. high the inside diameter is 15 ft. 5½ ins. The tunnels were driven by shield, with compressed air, except that a considerable length of the rock portion was excavated without a shield (as indicated in the profile Fig. 1). After the cast-iron lining was bolted up, the spaces between the ribs or flanges were filled with concrete to the height of the flanges. In the bottom of the tunnel was placed a shallow filling of concrete, with longitudinal steel rods imbedded to strengthen it against the shattering influence of train traffic, making a base for the track ballast; low concrete benches containing the cable ducts were formed alongside the roadbed, as shown in the cross-section Fig. 2.

The greatest depth of the tunnel is about 94 ft. below mean tide level. As the profile shows, sand prevails over a large part of the deepest section of the tunnel. The maximum air-pressure used in driving was 42 lbs. per sq. in., corresponding to 96 ft. depth. Ordinarily, however, the pressure was not over 35 lbs.; only on individual occasions was it as great as the head of water at the toe of the shield, and for considerable periods of time it was less than the head on the crown of the shield.

During the work of driving the tunnels there was found to be much difficulty in holding the shields to proper grade. Some trouble was experienced on this score in rock, as no concrete cradle forward of the shield was used. The serious trouble, however, occurred in the fine sand. The shield of the north tunnel especially exhibited a very strong tendency to sink below grade, and this tendency was generally controlled only after it had carried the advancing tunnel materially below the intended grade line. A report on this action was made by Mr. George S. Rice, Chief Engineer of the Board of Rapid Transit Railroad Commissioners, a year ago (reprinted in Engineering News of May 31, 1906, pp. 611-612). As there noted, the trouble had been first observed two years before, and continued during the larger part of 1904, 1905 and 1906. Mr. Rice attributed it wholly to the contractor's failure to maintain the air pressure high enough, and the consequent necessity of controlling the inflow of water at the face by pumping; this carried sand away from under the bottom of the shield and the forward portion of the completed lining, settlement being the natural result. The tunnel in consequence exhibited a succession of humps and dips instead of a continuous slope, departing sometimes as much as 10 to 12 ins. from true grade, and as it would not have been feasible to fit the track to this irregular profile, the desired clearance was seriously infringed upon.

Reconstruction of parts of the finished tunnel was necessary. Generally this was done by cutting down the humps in the profile by lowering the bottom. The bottom plates of the lining at these points were taken out (after breaking out one plate), and, under an air pressure sufficient to balance the full hydrostatic head, the soil below was excavated to the desired surface. New plates were cast, of suitable circular or elliptic shape to fit the new lines. When these were put in place they made the cross-section in the reconstructed portions oval or egg-shaped, but with the invert on a smooth grade line. The excess in height at these points over the normal cross-section was taken up in the concrete filling (see Fig. 2), which was carried below the line of the flanges of the top segments down to the desired roof contour.

At one point near the Brooklyn end, a short sag in the grade of the tunnel as built made it simpler to reconstruct the roof. This point can be located from the profile Fig. 1, where the reconstructed parts are indicated by a heavy black line drawn along roof or invert. Raising the roof

was done by raising the individual lining segments by means of hydraulic jacks, simultaneous with agitation of the overlying sand by stirring rods passed through holes in the plates.

Before the methods for doing this reconstruction work had been fully developed, some experimenting was done with the freezing process for consolidating the material outside the lining so that plates could be removed and the soil excavated. The process was not adopted, however, and in fact these experiments were not carried far enough to indicate its value for the purpose. It was found sufficient, in the soil encountered, to maintain an air pressure great enough to hold back the water, under which conditions the sand could be excavated something

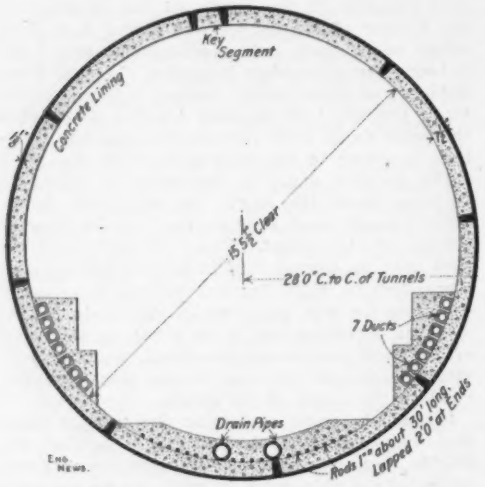


Fig. 2. Typical Cross-Section of One Tube of Battery Tunnel.

like a firm clay. The work of reconstruction was executed in part by the New York Tunnel Co., who are the subcontractors for the entire tunnel, and in part by Cranford & McNamee, who had previously built the Brooklyn approach section of the tunnel. At the present time this work is entirely completed.

This settlement of the shield and the resulting deviation of the tunnel from the true grade are not the only evidences of settlement which have appeared. Some slight settlements of the parts of the finished tunnel have been found where the tube had not been perfectly watertight. The air pressure being released before the joints were perfectly calked, the water, carrying fine sand with it, would escape through the imperfect joints into the tube and leave a space at the bottom of the tube with less supporting power than the surrounding material, and thereby allow the tube to settle. Such settlement has not in any case, however, continued after the leaks were closed.

The more serious cases, where settlements of 5 to 8 ins. appeared, were included in the above-noted work of reconstruction. The maximum deviation from grade due to combined sinking of shield and subsequent settlement was about 14 ins. The joint calking, which as remarked was adequate to stop all leakage, is shown in detail in Fig. 3.

In his report of May 22, 1906, already referred to, Chief Engineer Rice expresses very clearly his belief in the complete stability of the tunnel. He says:

> The material which we have encountered in the East River is such that, after the construction of the tunnel, it can absolutely be relied upon to stay in place. This material, while causing a less rapid progress than that which was found in the North River, which has a very large amount of yielding material, can always be depended upon to maintain the tubes in a safe and permanent position.

However, the Interborough Rapid Transit Co., which will operate the tunnel and which through an allied corporation, the Rapid Transit Subway Construction Co., is also building the tunnel, reached the conclusion that, to further assure permanent stability of the structure under all conditions and to increase public confidence in its safety, it would be desirable to provide some sort of foundation in that part lying in the "fine sand and clay," the least stable material encountered, just as the Pennsylvania R. R. is doing in its double tunnel under the Hudson River at 33d St., New York City. The lining of the Battery tunnel lacks the "bore-segments" of the Pennsylvania tunnel (see Eng. News, Dec. 13, 1906), or similar provision for sinking piles through the completed shell. But during the reconstruction of the lining to eliminate errors of grade, above mentioned, the fact had been shown that the material surrounding the tunnel is stable enough to permit of temporarily removing sections of the lining at the bottom and doing a certain amount of excavating in the soil. Therefore it would be feasible to put down piles in this soil after removing one or more bottom segments. A trial proved this possibility, and in consequence it was decided to put down foundation piles throughout the region of fine sand, a length of about 1,200 ft. in each tube.

Fig. 4 shows quite fully the construction designed. The foundation bents are spaced about 50 ft. apart longitudinally, with minor variations. Each consists of two concrete-filled tubular steel piles, spaced 7 ft. on centers transversely, sunk to hard bottom (either hardpan or rock) and capped with a concrete cradle formed around the bottom of the tunnel shell. The piles are 20 ins. in diameter, and are made of ½-in. steel plate in sections 5 ft. long. At first these were made slightly tapered, to telescope, being joined by bolts or pins. Later, however, the sections were simply butted, and were connected by splice strips riveted or bolted over the joint, outside. A 4-in. jet pipe passes through the center. Four vertical rods of 1-in. square steel, in lengths corresponding to the pile sections, are arranged in the interior of the pile in the manner of reinforcing rods, and at the bottom of the pile are brought to a point. The successive lengths of rod are jointed by lapping about 12 ins. The pile is filled with concrete while it is sunk.

In order to put down a foundation bent, three plates of a lining ring are removed, one being broken by sledges or jacks to enable the other two to be taken out. The soil below is then excavated to form a trench with level bottom, about 10 ft. long in a direction transverse to the tunnel, and extending under the adjacent ring on either side. Before the foundation is completed, plates are taken out of these adjoining rings also, there being usually a total of from 7 to 9 segments taken out. The sides of the trench do not require sheeting if the air pressure is kept up to the full hydrostatic head. The bottom section of each of the two piles is then set in place, its lower part being filled with concrete. Water is pumped through the 4-in. jet pipe and the piles are forced down by hydraulic jacks butting against the roof by means of distributing timbers. When one section is sunk another is set on top of it and jointed to it. Concrete is then filled into the pile to about the middle of the second section and the work of sinking resumed. As successive sections are added, the reinforcing rods and the jet pipe are extended. When the piles reach hard bottom the piles are completely filled, the reinforcing rods splayed out, and the entire trench filled with concrete as shown in Fig. 4. The surface of the

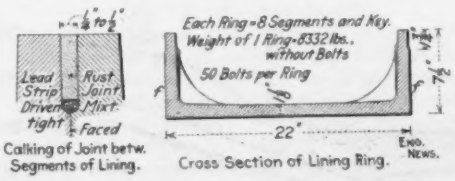

Lead Strip Driven tight
Rust Joint Mixt.
Faced
Calking of Joint betw. Segments of Lining.
Each Ring = 8 Segments and Key.
Weight of 1 Ring = 8332 lbs., without Bolts
50 Bolts per Ring
22"
Cross Section of Lining Ring.
ENG. NEWS.

Fig. 3. Dimensions of Cast-Iron Lining and Detail of Joint Calking.

concrete is kept 4 to 6 ins. below the outside of the lining in order to allow the last plate to be slipped in from the outside. Then the lining segments are replaced and bolted up, and finally the space between concrete and lining is grouted under pressure.

About twelve foundation bents of this character have been sunk up to the present in each tunnel, most of them in the section east of the rock reef at the middle of the tunnel. They have been sunk to depths varying from 10 to 50 ft.

This work is being carried out by the New York Tunnel Co., subcontractor under the Rapid Transit Subway Construction Co., in conjunction with the latter. The work has not received the authorization or approval of the Board of Rapid Transit Commissioners, as the latter do not consider it necessary construction, but no objection

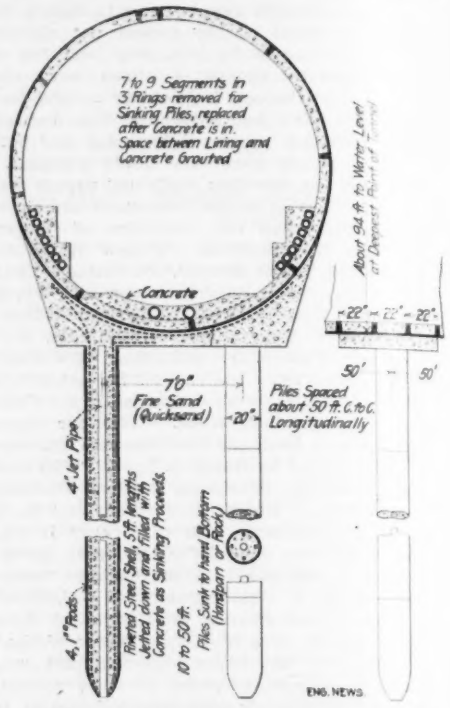

7 to 9 Segments in 3 Rings removed for Sinking Piles, replaced after Concrete is in. Space between Lining and Concrete Grouted
Concrete
About 94 ft. to Water Level at Deepest Point of Tunnel
22' 22' 22'
50'
50'
70' Fine Sand (Quicksand)
20'
Piles Spaced about 50 ft. C. to C. Longitudinally
4" Jet Pipe
4, 1" Rods
Riveted Steel Shell, 5 ft. lengths Jetted down and Filled with Concrete as Sinking Proceeds
10 to 50 ft.
Piles Sunk to hard Bottom (Hardpan or Rock)
ENG. NEWS.

Fig. 4. Cross-Section at Pile Foundation Bent.

has been made against the contractor's putting in these foundations. Mr. George S. Rice is Chief Engineer of the Rapid Transit Commission, and Mr. Frederick C. Noble is Division Engineer. Mr. Anton Schneider is Division Engineer in charge for the Rapid Transit Subway Construction Co., and Mr. Thomas Brown is superintendent for the New York Tunnel Co.

FORTY-FIRST ANNUAL CONVENTION OF THE MASTER CAR BUILDERS' ASSOCIATION.

As has been the custom for several years past the annual convention of the Master Car Builders' Association was held in Atlantic City from June 17-19, immediately succeeding the annual convention of the Master Mechanics' Association, which was reported in our last week's issue. The two meetings are more closely joined by the exhibition of the Railway Supply Manufacturers' Associations which continued through the entire week and which was made to be equally interesting to each association. The supply men, in their capacity as entertainers to the railway officials attending the convention, devoted all their afternoons and evenings to that work, and their efforts, together with the beautiful weather that prevailed throughout the week, gave to the meeting many pleasant features to accompany the business-like proceedings of the convention.

The Master Car Builders' Association holds a very important relation to the railway organization of to-day, inasmuch as the rules which it frames for standards of practice are almost invariably adopted by the railways of this country and of Canada and, what is perhaps of greater importance, are used as the basis for the guidance of the very strict inspection that the Interstate Commerce Commission maintains over the rolling stock of the railways of this country. There seems to be a complete accord between the government in this work and the railways, and every effort is made to get at a fair and equable set of standards which will not

only ensure safety to passengers and trainmen but also prove economical and structurally correct.

Although a rather lengthy program was prepared, full attention was paid to each paper and report with but a small amount of extra session in addition to the time called for in the arranged schedule. The first day's work was taken up entirely by the routine business, the President's annual address, an address by Mr. E. A. Mosely, Secretary to the Interstate Commerce Commission, and the report of the Committee on Revisions of Standards and Recommended Practice.

PRESIDENT'S ADDRESS.

The address of the President, Mr. W. E. Fowler, Master Car Builder of the Canadian Pacific Ry., gave in brief the proposed work of the convention. Recognizing the present public interest in the proper regulation of railway affairs and the increasing notice which the people are taking in the manner in which railways are operated, Mr. Fowler impressed upon the convention the necessity of a careful study of all the problems before it.

In the past it has always been the policy of the association to carry on all its investigations through its members, who took their own time and the time of the railways who employed them in which to do the work. As is generally the result in all similar associations, the work has fallen upon a few willing men, not through any particular desire of theirs to monopolize the administration, but rather from a lack of interest in the routine work displayed by the majority of the members. In view of this and the ever-increasing subjects which need a thorough study, the President recommended that a start should be made toward the establishment of a permanent expert staff which, to quote:

> would be qualified by education and training to handle problems either mechanical, chemical or physical, operated under the direction of the executive committee and sustained by the railroads of the country. Such a laboratory and staff actually in co-operation with the working committee of the association would return many times its cost to the railroads.

Among the subjects which were suggested for future study were: Freight car repair yards, the poor condition of which are largely responsible for the present car shortage; steel car design; ventilation and heating of passenger cars, and the necessity of one standardized coupler instead of the many standards now in use.

MR. E. A. MOSELY'S ADDRESS.

As in the last six annual conventions, Mr. E. A. Mosely, Secretary of the Interstate Commerce Commission, was asked to address the convention. After a reference to the very cordial relations which exist between the Master Car Builders' Association and the Interstate Commerce Commission Mr. Mosely entered into a discussion of the subject of car shortage. He said that one of the biggest causes of this condition was the reluctance of many railways to carry out the provisions of this association in regard to the repair of foreign cars. Much time is lost and money spent in shuttling back and forth between two roads a damaged foreign car, because neither road cared to undertake the necessary repairs—repairs that were fully provided for under the rules of interchange of the association. The charge was denied that the Commission was responsible for the present car shortage owing to its too rigid enforcement of the safety appliance law. The inspection of the Commission has always had in mind the idea of making cars safe rather than to exact penalties for any defects which they might have, and in very few cases have cars violating the safety appliance law been sent from one road to the other seeking repairs and incurring penalties during their transit.

Defects in the coupling mechanism rendering it inoperative has been the main cause of prosecution by the commission. Since the operation of the new Interstate Commerce law, about nine months ago, there have been 672 cases of this character. The most striking thing about these cases is that in many instances carriers have paid out hundreds of dollars in penalties that might have been entirely avoided by the expenditure of a few dollars in labor and material for repairs. A total of 282 violations, involving fines amounting to $28,200, could have been avoided by the expenditure of $68.03, or an average cost per violation of 24 cents. Two other conditions which are causes of great trouble are the unnecessary handling of chained-up cars and the bad condition of hand-brakes. Recent court decisions have made the procedure in such cases very plain.

There are still some things which the association should investigate and work upon. While present standardization of rolling stock has advanced so as to cover the majority of details, much work along this line remains to be done, principal among which may be noted more uniform rules for grab irons and the need of a standard uncoupling arrangement for passenger cars.

The responsibility of the carriers for the safety of their employees has been a source of much litigation during the past year. The railways have successfully fought the government in two cases, using the defense of an assumption of risk. In five other cases the Employers' Liability law has been upheld, and it would seem at present that the latter will in the end prove good law.

REPORTS OF COMMITTEES.

REVISION OF STANDARDS.—As has been noted, one of the principal purposes of this association is the enacting of rules standardizing the practice of car building. There is a standing committee on this subject which every year makes additions and changes to the existing long set of rules. The committee for the present year submitted many changes in detail construction, of importance only in the routine work of making, repairing and operating cars.

RULES OF INTERCHANGE.—The standing committee to formulate the rules of interchange of cars between various roads presented a lengthy report making many minor changes in the present code of rules. None of these were of any vital importance and were accepted as presented.

TESTS ON BRAKE SHOES.—The report of this committee is given in abstract in another part of this issue. This report was accompanied by an article by Mr. F. W. Sargent, entitled "A Review of the Progress in the Development of Railway Brake Shoes as Set Forth by M. C. B. Tests, 1895 to 1906, Inclusive." Mr. Sargent's paper, in accordance with the views of many of the members as developed in subsequent discussions, held that all laboratory experiments of the nature of brake-shoe tests should be supplemented by actual service tests. In spite of all efforts, no laboratory equipment can more than approximate service conditions. The conclusions of the paper read as follows:

> The questions to be decided concerning brake shoes in the future may be noted as follows:
> First: Extending the records of test to cover speeds of from 5 to 80 miles per hour under loads from 2,000 to 15,000 lbs.
> Second: The comparative durability or wear of brake shoes under similar conditions of service.
> Third: The comparative effect of various brake shoes upon the wheel tread, both as regards wear of wheels under the shoe and heat effect produced by the shoe upon the wheel.
> Fourth: The comparative merits of the unflanged and flanged brake shoe to note the advantage, if any, and better braking effect obtained with the flanged shoe which would seem to be indicated in service, as well as better effect on the wheel.
> With these questions settled, the brake-shoe story will be complete until some new metal stronger, tougher, but still retaining the grinding and non-cutting qualities of unchilled cast-iron has been obtained.

TESTS ON COUPLERS.—During the past year the Standing Committee on Tests of M. C. B. Couplers made a thorough investigation of the breakages and failures of approximately 5,000 broken steel couplers and 3,000 broken steel knuckles, with the view of obtaining reliable data concerning the location and nature of such fractures and to recommend such changes as will strengthen the couplers in the weakest parts, improve them and reduce failures to a minimum. The report tabulates the various forms and designs of couplers and knuckles, together with the most general points of failure in each class, and enumerates several detail changes in sizes on the standards. It is thought that a closer observance of the M. C. B. specifications in purchasing and testing coupler equipments will bring about a much more satisfactory state of affairs in coupler breakages. In line with Mr. Mosely's address, the committee called attention to the very great necessity for improvements in uncoupling devices, so as to do away, if possible, with the use of uncoupling rods, chains and clevise-pins. The committee was prevented from making any specific recommendation on this point on account of the several patented devices in the market to cover this very defect. It was stated in open meeting, however, that one or two of these patents answered the desired purpose to a great degree and deserved recognition.

WHEEL STRESSES.—A committee appointed to investigate the stresses to which wheels for 100,000 lbs. capacity cars are subjected reported that such work should be rightly carried on by some specialist in a railway laboratory. It, however, included in its report the following necessary points for consideration in making such a test:

> 1. Stresses Due to Load Imposed.—As the present pattern of cast-iron wheel provides the tread coned to a very much greater extent than the old type of wheel, it must, in our opinion, result in an excess of pressure on the wheel tread, resulting in a local deformation of that part of the wheel in contact with the rail; and these stresses recurring persistently, as the wheel revolves, tends to separate the fiber or fibers to an extent sufficient to produce a fracture.
> 2. The Stresses That Wheel Flanges Are Subjected to When Train Enters a Curve.—The extent of these stresses depend on the curvature of the track, the speed of the train, and the weight of the load the car is carrying. The location of the center of gravity of the car also has its effect.
> 3. The Effects of Brake Shoe Application and Form of Brake Shoe.—We believe all of these things could be handled to a very much better advantage by those who are especially equipped to carry out such tests, as the parties mentioned above.

Mr. G. L. Fowler, M. Am. Soc. M. E., has designed a dynamometer to measure actual maximum flange pressure on a working track, and this device is now being installed at a point on the Pennsylvania R. R. The association, therefore, asked Mr. Fowler to prepare a paper to be read at next year's convention which would give some details of pressure and stress under working conditions.

The reports of the following committees all made minor changes in the existing practice: On the Height of Brake Staff; On Rules for Loading Long Material; On Arch Bars; On High Speed Brakes;. On Cast Iron Wheels; On Tank Cars. Some little discussion occurred upon this last report concerning the proper stenciling of tank cars in regard to weight and capacity. Owing to the varying specific gravities of the different oils which are carried in tank cars, there has been much confusion among railway traffic men in accounting for the weights of material. The general opinion seeming to be that action by the car builders without advice from their respective traffic managers was inadvisable, the discussion of the question was left over to the following year.

The reports of the Committees on Triple Valve Tests and Air Brake Hose Specifications showed that the work was still unfinished, and the committees were therefore continued until next year. The Committees on Automatic Connectors and Clearances for Electrical Equipment, who were supposed to present reports at this meeting, failed to appear.

SUBJECTS FOR NEXT CONVENTION.—The following subjects are to be reported on at next year's convention, in addition to those mentioned before in this account: The Lateral Bracing of Steel Freight Cars; Side Bearings and Center Plates for Freight Cars and Locomotives; Friction Draft Gears; Steel Passenger Cars; The Ventilation and Heating of Coaches and Sleeping Cars and Protective Coatings for Steel Cars.

TOPICAL DISCUSSIONS.

The noon hour of each day's session of the convention was taken up with so-called topical discussions on subjects of interest to the members. These were opened by a written paper by some previously selected member and followed by a general oral discussion.

CLEANING OF PASSENGER EQUIPMENT.—This discussion was opened by Mr. P. H. Peck, who has charge of one of the largest car-cleaning establishments on the continent. In this yard in Chicago are cleaned from 6,000 to 7,000 cars per month from the Chicago & Western Indiana, Wabash, Monon, Erie & Grand Trunk railways. Coach cleaning may be divided into three parts: (1) Inside cleaning, in which the car body and structure should be cleaned by the compressed air blower system, and the floor then scrubbed, the carpets, cushions and draperies being afterward cleaned by the vacuum system. (2) Outside Cleaning, to preserve the paint and varnish by

the application of some cleaning mixture. (3) Truck and Under Rigging Cleaning, by wiping or brushing with oil. During the past year 89,026 passenger equipment cars were cleaned in this yard at an average cost per car of 77.8 cents. The itemized accounts of these were as follows:

Ordinary sleeping car	$1.96
Suburban coach	.32
Coach with oil lamps and closets	.26⅔
50-ft. baggage car	.22
50-ft. combination mail and baggage	.27
60-ft. mail car	.47
60-ft. baggage car	.32
Wide vestibule coach	1.29
Combination coach and baggage	.63
Wide vestibule chair car	1.48
Platform coach	.48
Dining car	1.85
Parlor car	.76

In the general discussion it was brought out that the cost of cleaning cars is extremely variable, owing to the very poor facilities generally allowed for such work and the reluctance of the traffic departments to let the trains remain a sufficient time in the yards. It was the general consensus of opinion that the new system of vacuum cleaning which has become so prevalent in hotels and residences can be used on cars only in company with the direct blower air system and with wiping.

CAR VENTILATION.—In opening this discussion Mr. Wm. McIntosh said that the moving railway car affords in action the necessary functions to bring about ideal ventilation, inasmuch as the very motion furnished the means of admitting fresh air and expelling the foul air. In general, proper ventilation could be brought about as follows:

Suitable openings or hoods would have to be provided at the end of the car, in the direction in which it is moving, to guide the air into a system of heated piping under the hood, the pressure engendered by the moving car forcing the air through suitable ducts extending over the interior of the car, toward the rear, with branches directed downward toward the seated passengers, the exhaust taking place through suitable openings in the floor—this to be accomplished by vacuum developing under the moving train as it is driven along. It would not be possible to furnish very complete ventilation in this manner unless runs were continuous for a considerable distance and proper mechanical arrangements made to close the floor ducts and open the hood ventilators when the train would stop. All systems are deficient here, ventilation ceasing when motion stops, and it is only by some independent forced system of ventilation that proper circulation of air can be kept up while the cars are standing. That some method will yet be evolved for a forced system of ventilation, controlled by independent motors, is quite possible, but it will necessarily be complicated and expensive.

SOLID STEEL WHEELS FOR PASSENGER CARS.—In an investigation for the last two years on the merits of wheels of various character in use in passenger and in freight service, Mr. George L. Fowler, M. Am. Soc. M. E., has reached some definite results as to the utility and value of solid steel wheels as contrasted with steel-tired and cast-iron wheels. These results were presented by him as the opening paper in a typical discussion on "Solid Steel Wheels for Passenger Cars," an abstract of which will appear in a coming issue.

LATERAL COUPLER CLEARANCES.—Up to 1905 the M. C. B. standard for coupler side clearance or movement was 1 in.; in that year a committee appointed to investigate the question reported in favor of a clearance of 2½ ins., which latter value was then adopted as standard. Since that time many roads have increased this value to as high as 4 ins. and bid fair to still further increase it. There are widely variant opinions held upon the desirability of such an increase, most of which were brought out in this discussion. The advocates of the wide clearance for couplers claimed for that practice a greater facility for coupling and movement on curves, and that throttling by the coupling device to ¾ in. on a side increased the wheel flange breakages. This latter statement was vigorously combated in theory by the 1½-in. clearance adherents, but the small amount of experimental data at hand seemed to support it. The final opinion seemed to be that, in spite of the tests in favor of small flange pressure from wide clearance, the tight coupler would give less pressure on the flange, but would throw more pressure on the car frame. There was no contradiction of the fact that the wide clearance made much easier traction around curves. The whole subject was then referred to a committee for a full report at next year's convention.

MASTER CAR BUILDER'S RELATION TO CAR SHORTAGE.—Mr. J. E. Muhlfield presented a paper for topical discussion upon "What Can the Master Car Builder Do to Secure a More Rapid Movement of Freight Cars?" Assuming that the traffic and transportation departments of the railways were exhausting every means to increase the movement of freight by greater lading and quicker handling of cars, the master car builder can render additional assistance by a consideration of: (1) Regulations to facilitate the handling and interchange points of loaded freight cars that are safe to move; (2) Competent interchange and terminal car inspectors; (3) More substantial repairs to cars on the home lines; (4) Thorough inspection, repairs and adjustment of cars before loading and careful attention to brake lubrication after classification at load originating terminals; (5) Repairing of cars for return loadings instead of routing home empty, such cars having been damaged by accident, but safe to move; (6) Restriction to home lines of cars that are not suitable for interchange service, and (7), Dismantling of cars unsuitable for either company's or commercial use.

OFFICERS.

The following officers were elected for the ensuing year: President, Mr. G. N. Dow, Lake Shore & Michigan Southern Ry.; 1st Vice-President, Mr. R. F. McKenna, Delaware, Lackawanna & Western Ry.; 2d Vice-President, Mr. R. W. Burnett, Canadian Pacific Ry.; 3d Vice-President, Mr. T. M. Ramsdell, Chesapeake & Ohio Ry.; Treasurer, Mr. John Kirby, and Secretary, Mr. Joseph W. Taylor, 390 Old Colony Building, Chicago, Ill., to whom all correspondence concerning the association or its publications should be addressed.

THE OFFICIAL BEGINNING OF CONSTRUCTION ON THE NEW CATSKILL WATER SUPPLY FOR NEW YORK CITY.

On Thursday, June 20, with simple but impressive ceremonies, Mayor George B. McClellan of New York City turned the first sod that marked the official beginning of construction on the huge Catskill aqueduct which is to bring an additional water supply to New York City from the highlands lying to the west of the Hudson River.

The readers of Engineering News have been made familiar with the preliminary work which has finally resulted in the undertaking of this great enterprise, the greatest, in point of total investment, ever undertaken by any city in the world. For two years a large force of engineers has been engaged on the surveys and plans, and the first contract for construction of a section of the aqueduct was let to the T. McNally Co. of Pittsburg a few weeks ago. While the contractor already has a force at work near the Hudson River crossing, it was deemed appropriate to celebrate the formal beginning of the work with due ceremonies.

On the morning of June 20 the steamer "Albany," of the Hudson River Day Line, carried a party of some three hundred city officials, engineers and invited guests from New York City up the Hudson to Cold Spring landing. Here carriages and automobiles were in waiting to convey the party a distance of some three miles to a spot on the banks of Indian Brook, which had been chosen for the official beginning of construction.

The entire work upon the new water supply system is directed by a commission of three, consisting of Messrs. J. Edward Simmons, Charles N. Chadwick and Charles A. Shaw. After religious exercises and the singing of the national anthem by the glee club organized from the water supply engineering force, President Simmons, of the commission, delivered an address, from which we quote as follows:

Under the shadow of the mighty Storm King, and on the banks of a broad and beautiful river whose shores, highlands and peaks serve to remind us of the heroic deeds of our Revolutionary patriots, we have assembled to celebrate an event full of joy, full of significance and promise to those who adequately appreciate the occasion.

We have come to assist at the beginning of a vast structure, a structure so vast that, by comparison, it will challenge the mightiest public undertakings of both ancient and modern times.

The works attributed to the mythical giants of the past were characterized by size and strength, and they invariably suggested force and might. On this spot we peacefully commence to-day a structure which in size and strength, will far exceed the mythical proportions suggested by the works of the Cyclops of ancient story, whose massive walls will be dwarfed by comparison with the huge dam at Ashokan, which rise a sheer 220 ft. from its base, and will enable the American engineers to laugh to scorn the historic proportions of the Babylonian wall of Semiramis.

The great reservoirs and aqueducts of Rome have been the wonder of mankind through twenty centuries. The Ashokan Reservoir—twelve miles long and two miles wide, with a water surface of 10,000 acres, and a capacity of 120,000,000,000 gallons—will exceed in size anything of its kind in the world's history. The Catskill aqueduct will pale into insignificance the famous aqueducts of the Imperial City because it will carry thirty times as much water as all the aqueducts of Rome combined.

The Board of Water Supply have called to their aid skilled specialists in every branch of approved modern science. They have asked the surveyor and the geometrician to determine grades and directions; they have summoned geologists to guard against hidden dangers that lurk in the bowels of the earth; they have bidden the chemist that he might banish from construction all the concealed agents of death and disaster, and they have directed the engineer, the mechanic and the ironworker, whatever his specialty, to examine every problem and to foresee every possibility. Having thus consulted the Oracle of Modern Science, having determined the route and the chosen methods, when, in a few years, this intricate water project will have become a fact, it is certain to stand as a colossal monument to the achievements of modern science and intellect.

But we must not forget that behind the gigantic material force here to be employed, behind the dazzling power of intelligence here to be displayed, the true and animating cause of all this magnificent creation is that which is most human—its patriotic and beneficient purpose, its lofty aim to serve mankind, its definite aim to make secure the health and prosperity of those who dwell in our great city.

Indeed, if we study the origin and the conduct of this mighty project, who can fail to see that it is a genuine offspring of the American system of government, that the sermon to be read in these stones will declare in truth that this is a creation of government, by the people, for the people?

By act of the Legislature a Board of Water Supply was created, with authority to call upon the people of the city of New York to appropriate the sum necessary to obtain an abundant supply of pure and wholesome water to meet the prospective needs of the rapidly growing multiple city at the mouth of the Hudson River. The taxes to be levied, as was foretold, will aggregate at least $161,000,000. Though the burden imposed was immense, though the sums involved would have bewildered the imagination of our forefathers, yet not a word of protest, not a word of criticism, was heard from the intelligent citizens who recognized the need for this important undertaking.

The law, as passed, was signed by the Governor on the third day of June, 1905. On the ninth day of the same month the Mayor appointed the commission. Two months after, the commission having made a careful examination of all possible routes, and having consulted the most distinguished and competent engineers the country could afford, finally decided that the Catskill plan was the most feasible. On October 9th, exactly four months after the Board of Water Supply was appointed, they submitted to the Board of Estimate for their approval a report setting forth the complete plan of the undertaking. Forthwith they organized a force of accountants to record the expenditures of the complicated business to be started. Carefully and expeditiously they selected the engineers destined to work out the technical side of the enterprise. With discretion and prudence they recruited well-nigh six hundred men of science, who are to execute the details of the scheme. To-day all this preparatory work is substantially finished. To-day, a little more than two years after the passage of the law, the commission has matured the plan to the point of initiating its material execution.

The spade lies ready and the first sod will soon be turned. With speed and energy, with intelligence and caution, with honesty and thrift, under the watchful eye of civic wisdom and the fostering care of far-sighted science, the project starts into life as a model for all similar undertakings, an example and an inspiration for all public servants who desire to fulfill their public duties faithfully, swiftly and conscientiously.

Commissioner Chadwick, on behalf of the Board of Water Supply, then presented to Mayor McClellan a steel spade with inlaid silver inscription, and with its handle fashioned in shape of the cross-section of the aqueduct. Mayor McClellan's speech in accepting the spade was substantially as follows:

We have met here for the purpose of beginning the physical work on the new Catskill water supply system. Exactly two years ago to-day the organization of the engineering force was completed, and in that remarkably short time almost the impossible has been accomplished. What has been done in the last twenty-four months has already been told to you, but the preliminary work was equally important.

When I took office January 1, 1904, I found myself confronted with a possible water famine, and with nothing practical done for its avoidance. The imminence of the peril was appreciated by the few who had studied the question, but the public at large did not understand its seriousness, nor was there any public sentiment in favor of its speedy solution. Some preliminary work had been done, and done well, but that was all. My administration found it necessary to do three things before a new water supply system could be actually undertaken. First, it was necessary to provide an additional borrowing capacity to meet the expenses of the undertaking, by means of a constitutional amendment which had passed the Legislature but had not been submitted to the people. Second, it was necessary to enact legislation so as to make the powers of the local authorities certain. And third, and most important, it was necessary to arouse public opinion so that the first two obstacles could be removed.

When public opinion was once aroused the rest was easy. I do not believe that it would have been possible for me to have accomplished anything but for the constant and unswerving loyalty and help of those about me, especially of my office staff, or the present Water Commission, of the force of the Corporation Counsel's office, and of the then chief engineer of the Aqueduct Board [Mr. J. Waldo Smith, M. Am. Soc. C. E., now Chief Engineer of the Board of Water Supply]. Nor could we have aroused public opinion without the help of the public-spirited civic organizations, first and foremost among which was the Manufacturers' Association of Brooklyn, under the insistent, consistent and persistent direction of our commissioner, Mr. Chadwick.

Public spirit aroused, the constitution amended, and the necessary legislation enacted, I was fortunate enough to obtain the services of the present commission. As has been told you, because of a pledge I had given, my selection was limited to nine names, submitted by the Chamber of Commerce, the Board of Fire Underwriters, and the Manufacturers' Association. But had my choice been unlimited I could not have done better than I did in obtaining Mr. Simmons, Mr. Shaw and Mr. Chadwick. May they continue to administer their trust earnestly and efficiently, with an eye single to the public welfare.

The course of human events is not permanently altered by the great deeds of history nor by the great men, but by the small daily doings of the little men. It was not the stern and silent commander at Waterloo, but the men who stood unmoved in the unbreakable squares, drawn from the highways and the byways, from the field and from the towns of England—who revolutionized the history of the world.

No more pernicious aphorism ever consoled the disappointed or the broken-hearted than that which declares that "it does not matter, it will be all the same in a hundred years." It will not be all the same.

Throw a pebble in the Hudson. It makes its little splash and as the rings grow wider and finally disappear out of sight they disappear out of mind, and yet as they reach the shore they have their direct effect upon the banks and upon the course of that mighty river as it rolls unceasingly to the sea. Every word we utter, every act we do has its direct bearing on the future of our race. I am one of those who believes that as time goes on the world grows better, and that as man was made in the image of God, so he who believes in the Almighty must have faith in mankind. Every idle thought, every thoughtless deed, spoken or done by the least of us, retards; every word spoken in righteousness, every deed performed with a right good will, tends toward the progress of humanity. Nations grow powerful and strong, and lead the world, or weak and decadent, and disappear as the atoms which compose them succeed or fail in doing their duty.

We live in an age of sensationalism. We tend to the worship of success as the only true god, and yet for every man who succeeds in the world's eyes a million fail, and if success in the worldly sense is all that is worth living for, then is the price of life too heavy a price to pay. The praise of the world is fitful and uncertain. A man who is praised to-day, through no fault of his, may be condemned to-morrow. A man who was condemned yesterday, equally without reason, may be the popular idol of to-day.

There is a success that far transcends in worth—that of being able to raise one's self a little higher than one's fellows, and that is the success of the consciousness of having done one's best—the success which comes from doing one's duty as one finds it, according to the grace and the light and the opportunity that is given one, regardless of what the world may say.

We speak constantly of the pride of profession, but all too little of the pride of trade. In exalting the purely intellectual occupations, we often depreciate the handicrafts. It is true that machinery has largely taken the place of manual labor, and yet, at the last analysis, as much depends as ever upon the man who labors with his hands, controlled and guided by an active brain.

The glory of the middle ages, its cathedrals, differ from each other not only in accordance with the genius of their architects, but even more in accordance with the spirit of their artisans. How many of you who have wondered whose was the brain that designed the cathedral at Rheims, or Amiens, has given a thought to the men who worked under him? Yet so much depended upon them, and if what they wrought is beautiful, it is that they labored not only because they had to, but that their hearts were in their work; and so, even with the humblest, the artisan became the artist.

If this great work of ours is to accomplish the purpose for which it is intended, it can only succeed because the men in the ranks have done their duty for duty's sake; have done their best because it is their best.

As the years merge in the decades, and the decades in the centuries; when time has thrown his kindly veil over the bickerings and the differences and the quarrels which seem so much to us, and are, after all, so futile and so petty; when friend and enemy, traducer and traduced, hero and admirer, have passed away; when you and I, and all of us who are sitting here now, have gone to our long rest, and our very names shall have been forgotten; when this great work, conceived in honesty, begun in honesty, and, God willing, completed in honesty, shall be ministering to the health and happiness of millions yet to come, then God grant that those who shall see it in the distant years may say, "It does not matter how they were called who did this thing, or who they were, or what they were; it is enough to know that they did their duty.

After the conclusion of the ceremonies the party returned to the steamer and were carried up to the site where borings and shaft sinking are in progress for the deep tunnel crossing under the Hudson at the northern entrance to the Highlands, opposite Storm King Mountain. The evening was spent in the return journey to the city. The voyage down the river was enlivened by songs from the Board of Water Supply Glee Club, an organization made up from the engineering force on the work. Most of the songs were original productions set to popular tunes, and celebrating various features of the work on which the engineers are engaged. We venture to take space for a few of these songs, as follows:

Tune—"I've Been Working on the Railroad."

We've been working on the Hudson
For a year or more,
Vainly searching for the bottom
Only found it at the shore.
But we still keep on a drilling
And we'll find it in the spring.
Then you'll see there's something doing
Up at Old Storm King.

Tune—"Bring the Wagon Home, John."

Oh! bring the transit home boys,
It will not work at all;
I stubbed my toe against a rock
And down with it did fall.
The tangent-screw is busted
The upper limb won't stay
I fear that it will surely cost
My salary check for May.

Along came Jimmie Sanborn
So full of confidence
And soon our fears so scattered were
They looked like thirty cents.
He took the busted transit
So tenderly in hand
An axe and nail-file did the job,
We again surveyed the land.

Tune—"In the Good Old Summer Time."

There's a time in each year, we very much fear,
It's the good old summer time,
They send us to Atwood, way up in the back woods,
That's not a very good time.
Many weeks we stay there, many miles from nowhere,
And we survey the line,
We stay in our camp, and we rot in the damp,
In the good old summer time.

Chorus.

In the good old summer time,
In the good old summer time,
We lug these stadia rods around,
And we survey the line,
And when they take the transit back,
Why that's a very good sign,
That some dam reading don't check up,
In the good old summer time.

Air—"Everybody Works but Father."

Everybody works for Waldo
We'll turn night into day,
To dam the Hudson River
Or drain out New York Bay.
The work we'll do for Waldo
Is really past belief;
We'll call on you for three cheers
For our own chief.

A COLLISION on the New York, New Haven & Hartford R. R., between a passenger train and a work train in a street of Hartford, Conn., is regarded to have killed 9 workmen and injured 35, on Sunday, June 23. There are three conflicting versions for the cause of the wreck; one statement is that the men on the work train opened the switch and failed to close it.

IN A HEAD-ON COLLISION between a passenger train and a freight train on the Auburn Division of the New York Central R. R., 4 persons were killed and 40 injured on the night of June 23. Both trains were running at a high rate of speed, and the impact when the two engines came together shattered the coaches.

A SPEEDING TRAIN broke in two on the Pittsburg & Lake Erie R. R. on June 22, killing the conductor and injuring 10 passengers in the resulting smash-up. It was the New Haven accommodation train on the Monongahela and Youghiogheny division, and had just left the station at Pittsburg; it was five minutes late, was running fast through the yards, and was well filled. A defective switch is thought to have been the cause; the smoker left the main track at the switch, and, with the baggage car, was thrown against a loaded gondola. The sides of the cars were torn away, the injured persons being those sitting on that side of the train.

THE "LAKE SHORE LIMITED" on the Big Four R. R. was derailed at Columbus, O., on June 17 by an open switch about three miles east of the city. Despatches state that the engine and all the coaches were thrown on their sides, and although the train was running at the rate of 50 miles an hour no passengers were killed, although a number were severely injured.

The cause of the wreck was an open switch, which is believed to have been tampered with by some boys of an investigative turn of mind.

A FALLING ROCK IN A RAILROAD TUNNEL near Mitchell, Ind., cut in two a passenger train on the Baltimore & Ohio S. W. R. R. which was passing through the tunnel on the night of June 19. It is reported that 17 persons were injured, although there was no loss of life.

A TRAIN WEIGHING 2,300 TONS was hauled over a single-phase electric railway from Palouse to Spokane, Wash., 76 miles, on June 9. The line of railway is the Spokane & Inland Division of the Inland Empire System. The train carried a traveling circus, and was made up of five 60-ft. Pullman coaches, seven standard stock cars, and eleven 60-ft. flat cars. The train was hauled by two 50-ton 600-HP. Westinghouse locomotives.

A HEAD-END TROLLEY COLLISION near New Britain, Conn., on June 22, is reported to have killed the motorman and injured 15 passengers. The motorman of one of the cars left a passing siding after waiting a short time for the other car, and tried to make the next siding. The two cars met on a curve, and he was killed.

A DAM FAILED near Fort Collins, Colo., on June 15, making considerable trouble along the Cache la Poudre River. The dam holds back Chambers Lake, which has a capacity of about 70,000,000 cu. ft. of water. Within an hour after the break occurred at 6 a. m., the Cache la Pondre rose nearly 10 ft. near the town of Home. When the flood reached the head of the Fort Collins water system, the river rose 4 ft. in a very few minutes. Press reports indicate that the amount of damage done was not considerable.

A SMOKE-STACK UNDER REMOVAL at the new soap factory of Proctor & Gamble, near Arlington, Staten Island, N. Y., came in contact with overhead live wires and caused the death of four of the workmen. The smoke-stack was attached to a boiler and the latter was mounted on a low truck with wheels. The workmen did not see the wires overhead, and four of them were touching the metal part of the boiler when the stack came in contact with the wires. Some of the wires burned through and the ends fell among three other workmen, two of whom were struck. Only the four men who were touching the boiler were killed.

AN EXPLOSION IN THE GELATIN DEPARTMENT of the Sinnemahoning Powder Manufacturing Co., Sinnemahoning, Pa., killed, on June 18, five men who were working in the building at the time, according to a press dispatch. The cause of the explosion, it is said, is not known.

A NEW DANGER TO FIRE FIGHTERS developed at a fire on the top floor of a manufacturing building at Spring and Crosby Sts., New York, on June 17. A stand-pipe was heated by the fire, and a captain and two firemen connecting a hose to the upper end of the

stand-pipe were badly scalded when the order to pump was given. The moment the stand-pipe gate on the eighth floor was opened, a cloud of steam burst from the nozzle of the hose which was being held by one of the firemen, rendering it so hot that he was obliged to drop it.

The hose squirmed about on the floor, still spouting steam. The firemen threw themselves upon it but were unable to hold it. Men from another engine company finally came to the rescue and recovered it, but by that time there was hot water coming from the hose, and in a few moments water of the usual temperature issued.

TWO FIRE-DAMP EXPLOSIONS in the Johnson No. 1 mine at Priceburg, Pa., on June 18, killed seven men and injured two. The gas accumulated through the carelessness of a door tender, who left the door open.

A PREMATURE BLAST on June 17 in the excavation for the Pennsylvania tunnel, at Ninth Avenue, Thirty-second and Thirty-third Streets, New York, made havoc in the timber and plank covering over Thirty-third Street and caused the death of one workman and the injury of another. Some of the timbers were blown clear over the elevated railroad structure, one being thrown two blocks away; an 8-ft. log falling upon him caused the death of the workman. Two elevated trains, going in opposite directions, just missed the flying debris, and the tracks were covered with it.

CONCERNING THE NEW "DREADNOUGHTS" for the U. S. Navy, bids were received by the Secretary of the Navy on June 20 at Washington for the construction of two battleships, Nos. 28 and 29, not to exceed 20,000 tons. Each bidder bid upon but one vessel. Class 1 is on Government plans and specifications for hull, equipment and machinery; Class 3 is on Government plans ad specifications for hull and equipment, bidder's plans and specifications for machinery. All deliveries are to be made in 36 months or under, and the speed of the vessels is to be 21 knots unless otherwise specified. Bids cover both reciprocating-engine equipment and turbine equipment. The contracts were awarded to the Newport News Shipbuilding & Dry Dock Co., whose figure was $3,987,000, and the Fore River Shipbuilding Co., whose figure was $4,377,000.

THE BOYDEN PREMIUM offered "to any resident of North America who shall determine whether all rays of light, and other physical rays, are or are not transmitted with the same velocity," has finally been awarded, 48 years after Uriah A. Boyden, of Boston, deposited the sum of $1,000 with the Franklin Institute.

This has been advertised monthly since then, and the advertisement is very familiar to all readers of the "Journal of the Franklin Institute."

The premium was awarded to Dr. Paul R. Heyl, of the Department of Chemistry, Central High School, Philadelphia, Penn. He demonstrated that the ultra violet waves have the same velocity as the luminous. The source of light was taken as the fixed star Algol, constellation of Perseus, which is known to have a periodical change of brightness.

The ultra-violet rays of a definite wave length were separated by a diffraction grating, such as is used in determining wave lengths of light and focused onto a sensitized photographic plate. Plates were exposed for 20 minutes every half hour during the visible cycle of changes of Algol's light, or about six hours.

The plates on developing showed a fading and intensifying effect of the invisible rays. As the plates required a 20-minute exposure, the exact time of minimum emission of ultra-violet rays could not be exactly determined, but a close approximation could be found, which agreed with the visible minimum.

The tests were repeated many times during a period of two years. The committee awarding the premium was composed of Mr. Hugo Bilgram, M. Am. Soc. M. E., Dr. Geo. F. Stradling, Northeast Manual Training School, Prof. A. W. Goodspeed, University of Pennsylvania, all of Philadelphia.

THE AMERICAN MONORAIL CO. has placed in operation its line at the Jamestown Exposition. The line is nearly a half mile in length and operates over a private right of way, without grade crossings, for its entire length. The car used on the line is 47 ft. in length and 6 ft. in width, and is driven by eight motors of 20 HP. each.

PERSONALS.

Prof. Francis A. Thompson has been appointed to the chair of mining and metallurgy at the Washington State College, Pullman, Wash.

Mr. C. M. Dugan, Jr., Superintendent of the Kosmos Portland Cement Co., has been made manager of the Plant at Kosmosdale, Ky.

Mr. J. D. Stuart, of Brooklyn, has been appointed Chief Engineer in charge of the survey for the Omaha-Hastings electric railroad, Nebraska. He succeeds Mr. W. H. Fuller, resigned.

Mr. Glenville A. Collins, formerly Engineer of the Railroad Commission of the State of Washington, has opened offices for consulting civil and mining engineering at 717 New York Block, Seattle.

Mr. Isham Randolph, M. Am. Soc. C. E., has resigned his position as Chief Engineer of the Chicago Sanitary District, in charge of the drainage canal and auxiliary works, and will go into private practice.

Mr. A. A. Lane, formerly with the Taylor Wilson Mfg. Co., of Pittsburg, has been engaged by the General Fireproofing Co. as office manager of the reinforced concrete department of their works at Youngstown, O.

Mr. Foster M. Voorhees, of Elizabeth, N. J., former Governor of New Jersey, was appointed by Gov. Stokes on June 19 as a member of the Potable Water Commission. The appointment was confirmed by the Senate.

Mr. H. A. McMore, formerly Engineer with the Harlem Contracting Co., of New York City, has been engaged by the General Fireproofing Co. at their works at Youngstown, O., in the reinforced concrete department.

Mr. O. E. Falch, Jr., formerly Chief Engineer of the Pacific Coast Branch, Otis Elevator Co., has opened offices for consulting in electrical and mechanical engineering, at 850-852 Monadnock Building, San Francisco.

Mr. A. B. MacDaniel, of the Case School of Applied Science, Cleveland, has been appointed Assistant Professor of Civil Engineering and acting head of the department at the University of South Dakota, at Vermillion.

Mr. David H. Moffatt, of Denver, Colo., has been elected President of the Denver Union Water Co. and of the Mountain Water-Works Construction Co., to fill the vacancies left by the recent death of Walter S. Cheesman.

Mr. J. F. Peters, of the engineering department of the St. Louis, Iron Mountain & Southern Ry., has been transferred from Little Rock to the office of the Principal Assistant Engineer at St. Louis. He is succeeded at Little Rock by Mr. P. Carroll.

Mr. H. G. Kelley, M. Am. Soc. C. E., has resigned his position as Chief Engineer of the Minneapolis & St. Louis Ry. and Iowa Central Ry. He is to become Chief Engineer of Maintenance of Way of the Grand Trunk System, with offices at Montreal, P. Q.

Mr. R. E. Fox, Jr., has resigned as Manager of the New York office of the Platt Iron Works Co. to become Sales Manager of The Engineer Co., 111 Broadway, New York. Mr. Fox was for three years manager of the southern territory of the Platt Iron Works Co.

Mr. Chas. R. McKay has been appointed Electrical Engineer and Superintendent of Lighting of the Toledo Railways & Light Co. He is a former Cincinnati man, where he has spent seven years as Chief Engineer for the General Electric Co. He will take up his new duties on July 1.

Mr. Walter Cook was on June 21 appointed City Architect for New York City. The many municipal improvements projected, such as bridges, the new penitentiary on Riker's Island, etc., made a city architect necessary. Mr. Cook is a member of the Municipal Art Commission.

Mr. John R. Burke, for ten years Assistant Engineer of the Massachusetts Board of Harbor and Land Commissioners at Boston, has resigned to engage in contracting for dredging and river and harbor improvements. He will be located temporarily at 56 Lincoln Avenue, Wollaston, Mass."

Mr. Wm. C. Lounsbury has been appointed Superintendent of Water-Works by the Superior (Wis.) Water, Light & Power Co. He was formerly chemist and bacteriologist for the company, and will retain those duties. He is a graduate of the Massachusetts Institute of Technology, and previous to going West was associated with Hazen & Whipple, Consulting Engineers, New York City.

Mr. Wm. D. Ennis has been appointed Professor of Mechanical Engineering in the Polytechnic Institute, Brooklyn, N. Y. For the past two years Prof. Ennis has been making special power investigations for the American Locomotive Co., New York City. He was one of the first to hold the American Railway Master Mechanics' Association scholarships at Stevens Institute, and before that he served an apprenticeship with the Baldwin Locomotive Works.

Mr. E. D. Edmonston recently joined the engineering staff of W. S. Barstow & Co., 50 Pine Street, New York City. Graduating from Lehigh University with the degree of E. E. in 1898 he entered the employ of the Westinghouse Electric & Manufacturing Co., at East Pittsburg, Pa., being connected with their engineering department. Subsequently he resigned to accept a position with the Lackawanna Steel Co. as Electrical Engineer and Superintendent at the time of the inception of their large Buffalo plant, making many then new electrical applications in rail and steel mill work. From there he was called to the Chief Engineership of the American Construction Co., of New Orleans, and during several years' service in that capacity obtained valuable experience in all branches of general construction work.

Mr. Joseph Ripley, M. Am. Soc. C. E., whose resignation as Assistant Chief Engineer of the Panama Canal was announced last week, has been appointed Supervisory Engineer to Mr. F. C. Stevens, Superintendent of Public Works for the State of New York. Mr. Ripley is a native of Michigan and graduated as civil engineer from the University of Michigan in 1876. For many years following his graduation, he was engaged in engineering work on St. Mary's Falls canal and St. Mary's River, and had full charge of the operating, engineering and construction work on these canals. In 1897 he had charge of the survey and preparation of plans and estimates for canal connection between Birmingham, Ala., and the Warrior River. In September, 1905, he was appointed a member of the board of consulting engineers for the Isthmian canal and served in that capacity until February, 1906. In August last he was appointed Assistant Engineer of the Isthmian canal, being in charge of the designing and construction of locks. In February last he was appointed Assistant Chief Engineer of the canal, and has been employed in that capacity until his resignation. In his new position, Mr. Ripley's duties will be to make a close study of the Barge Canal construction work in progress and to examine all plans and specifications hereafter to be prepared for the work.

Obituary.

Mrs. George W. Fuller, the wife of Mr. G. W. Fuller, M. Am. Soc. C. E., died in New York City on June 21.

Parry L. Wright, Vice-President and General Manager of the Luxfer Prism Co. of Chicago, died on June 22.

Capt. W. J. Downs, who laid out the Miami and Erie Canals, assisted in the construction of the St. Mary's reservoir (Ohio), and surveyed the "Panhandle Route" of the Pennsylvania R. R. between Pittsburg and Chicago, died on June 20 at Black River Falls., Wis., at the age of 91. He was also known as a philsopher and a poet.

John F. J. Mulhall, an accountant associated with Mr. Wm. Wheeler, M. Am. Soc. E. E., 14 Beacon St., Boston, died recently. He was the author of a book on accounting for water-works, electric lights, etc., and was scheduled for a paper detailing some of his water-works accounting experiences, to be presented before the convention of the American Water-Works Association at Toronto last week.

William Findlay Shunk, whose name is familiar to most American railway locating engineers, particularly those of a long experience, died at his home in Harrisburg, Pa., on June 22. He was born at Harrisburg on Sept. 26, 1830, and was the son of a former Governor of Pennsylvania and a grandson of Governor Pollock. He was graduated from Harrisburg Academy and Dickinson College, and was a midshipman in the U. S. Navy from 1846 to 1850. He then entered the Pennsylvania R. R. service, and, with the exception of a short time in the U. S. Coast Survey and service in the State Department at Washington during the Civil War, he was engaged in railway work during most of his long professional career. Among some of the railways with which he was connected during his early life were the Dutchess & Columbia, Connecticut Western and Lewisburg & Spruce Creek. He spent many years in connection with the construction of the elevated railroads of New York City. From 1868 to 1874 he was Chief Engineer of the Metropolitan Elevated of New York, and from 1876 to 1882 he was Chief Engineer of the Manhattan Elevated. From 1887 to 1889 he was Chief Engineer of the Kings County Elevated Railroad in Brooklyn. Some of his notable work in railroad location was in connection with the South Pennsylvania R. R. enterprise from 1882 to 1885. In recent years he had been engaged in railway location work in South America, part of the time in connection with the Intercontinental Railroad survey and later with the Guayaquil & Quito R. R. Mr. Shunk became well known to the engineering profession by his treatise on railway field work, first issued in 1854, which passed through 15 editions and has been generally recognized as one of the most thoroughly practical works ever issued in that field.

ENGINEERING SOCIETIES.

COMING MEETINGS.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
July 1-3. Annual meeting at Cleveland, O. Secy., W. T. Magruder, Ohio State University, Columbus, O.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Annual convention at the City of Mexico, Mexico, beginning July 8. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

ILLUMINATING ENGINEERING SOCIETY.
July 30-31. First annual meeting at Boston. Secy., Dr. A. H. Elliott, 4 Irving Place, New York.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Aug. 7-9. Annual meeting at Norfolk, Va. Secy., Frank P. Foster, Corning, N. Y.